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WATER QUALITY INVENTORY AND MANAGEMENT PLAN

UPPER CLARK FORK RIVER BASIN
MONTANA

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WATER QUALITY INVENTORY AND MANAGEMENT PLAN

UPPER CLARK FORK BASIN, MONTANA

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WATER QUALITY INVENTORY AND MANAGEMENT PLAN

UPPER CLARK FORK BASIN, MONTANA

I. INTRODUCTION

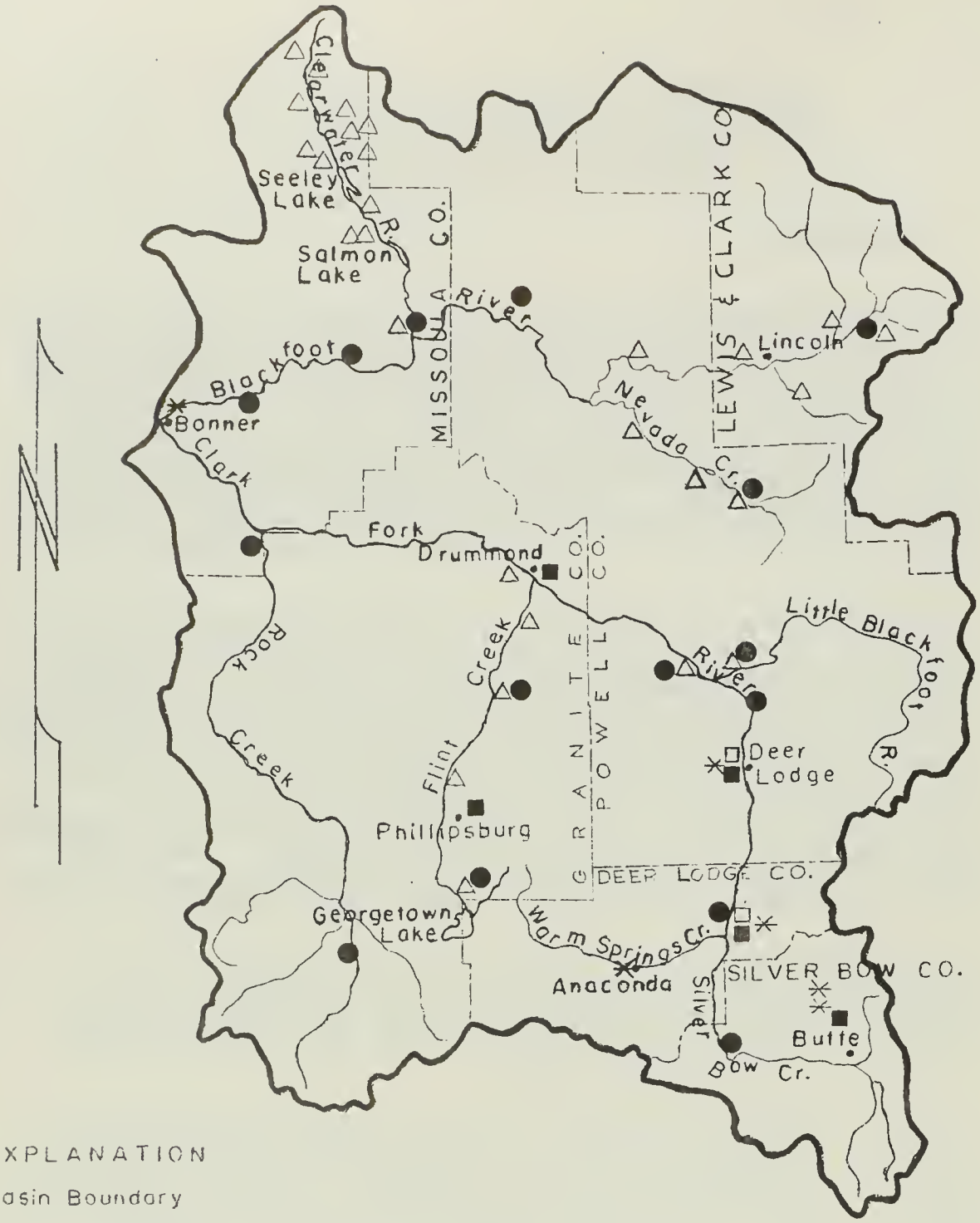
This report presents water quality and water quality related information in the Upper Clark Fork basin (Figure 1 and Plate I). The Upper Clark Fork basin is one of sixteen basins designated by the state of Montana for preparation of water quality management plans. The Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500) have directed states to prepare such plans as part of a nationwide program for controlling water pollution. The primary purpose of this report is delineation of water quality and water quality related problems. For this reason, considerable time is spent discussing factors affecting water quality.

Secondary objectives of this plan are to provide the state with water quality data and related information to (1) determine water quality characteristics of all natural and wastewaters, (2) develop a management strategy for maintaining and enhancing the quality of waters in the basin, and (3) provide information needed to determine whether Montana's water quality standards are being met and will continue to be met. Also included is a description of physical characteristics of the basin. General methodology used in this study was the compilation and evaluation of existing water quality data and related information. Where information was deficient, field investigations and water and wastewater sampling and analyses were conducted to obtain needed information.

This investigation does not present a detailed analysis of the area's resources but summarizes water quality related information. As additional information becomes available, the Upper Clark Fork basin water quality management plan will be revised and updated as part of Montana's continuing planning process.

Assistance in obtaining information for this report was obtained from a number of agencies and persons. The Montana Department of Natural Resources and Conservation provided information on land use, water use, economy and population. Flow data were obtained from the United States Geological Survey. The Anaconda Company was helpful in providing industrial treatment information and discharge characteristics as well as chemical data on Silver Bow Creek. Federal waste discharge permit information was obtained from Richard T. Montgomery, U. S. Environmental Protection Agency State Engineer for Montana; the Montana Department of Fish and Game supplied chemical and biological information.

Abbreviations and symbols used in this report are defined where first used and in Appendix A.



EXPLANATION

- Basin Boundary
- County Boundary
- Perennial Stream
- Stream flow gaging station (U.S.G.S)
- Water treatment plant discharge
- Discontinued W.Q.B Sampling site
- Existing W.Q.B. Sampling site
- Sewage treatment facility discharge
- Industrial discharge

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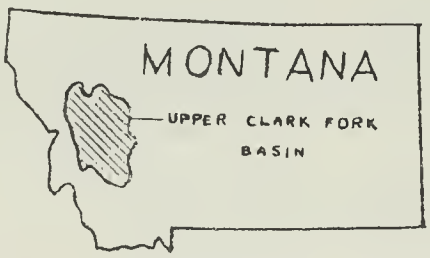


FIGURE 1. SKETCH MAP SHOWING THE UPPER CLARK FORK RIVER BASIN

II. SUMMARY AND CONCLUSIONS

Generally water quality in the Upper Clark Fork River Basin is good and the water is suitable for the designated beneficial uses. Several stream segments are designated as water quality limited, and do not meet Montana's Water Quality Standards. They are:

(1) Clark Fork River from Cottonwood Creek near Deer Lodge to the Blackfoot River. Excessive algal growths present in this segment.

(2) Blackfoot River downstream to the confluence with Alice Creek. Toxic metals and metal bearing sediments inhibiting aquatic organisms.

(3) Landers Fork and the North Fork of the Blackfoot Rivers. These rivers particularly the lower halves, have heavy sediment loads during spring runoff.

(4) Union Creek. Contains an excessively high sediment load.

(5) Bear Trap Creek from Mike Horse Mine downstream to the Blackfoot River. Toxic metals stop fish growth and reproduction.

(6) North Fork Blackfoot River. Excessive sediment.

(7) Placid Lake. Eutrophic causing algae blooms and low DO.

(8) Georgetown Lake. DO problems during winter.

Non-point sources related to land use are the most serious water quality problems in the basin. Logging, agriculture, mining, and recreation have been identified as important factors which now affect or may affect water quality in the basin.

There are six municpal, six industrial, and one agricultural discharges in the Upper Clark Fork River Basin. Permits have been issued under the State or Federal discharge permit system for each of these discharges. State compliance schedules have been established for four municipal discharges. Of these, Silver Bow Municipal Treatment Plant is on a compliance schedule for sludge disposal. The waste disposal plant at Galen needs chlorination to comply with July 1, 1977 standards. Deer Lodge and Philipsburg have had their compliance schedules postponed until grant funding becomes available.

The Anaconda Company at Anaconda is on a complaince schedule. The Chicago, Milwaukee, St. Paul and Pacific Railroad at Deer Lodge, the Anaconda Company - Butte Operations, the Anaconda Company - Continental East Pit, and U.S. Plywood at Bonner presently meet 1977 standards.

The main stem of the Clark Fork River is recovering due to significant efforts by the Anaconda Company to control toxic metal-bearing wastes. Additional work is needed on the Clark Fork River to determine its recovery and to examine the recent problem of algal growths in the Clark Fork River downstream from Deer Lodge.

A surveillance plan is described in this report and a description of basin needs and a management strategy is outlined.

III. RELATED INVESTIGATIONS AND PLANS

The following water quality related investigations or plans have been completed for the Upper Clark Fork River drainage or are in progress.

1. Fox (1972) discussed the water, sediment, and biological condition of Silver Bow Creek prior to the large-scale alteration of the mining waste scheme of the Anaconda Company. The report concluded that the water quality was very poor and the aquatic organisms were virtually absent in the stream.

2. Blackfoot River Water Quality Study, a report by Spence (1975) presents a compilation of water quality data collected from early 1968 through 1973 to determine existing water quality of the Blackfoot River and its tributaries. This water quality investigation established background conditions related to potential mining that might occur in the Upper Blackfoot River drainage basin. Basic data in this study show that the river system, with few exceptions upstream, is a high quality stream. Some degradation of water quality was noted in the vicinity of acid mine drainages in the upper most portion of the Blackfoot River drainage.

3. Geology and groundwater resources of the northern part of the Deer Lodge Valley, Montana, were discussed by Konizeski, McHurtrey, and Brietkrietz (1961). This report described the results of investigation of geology and groundwater resources of the northern Deer Lodge Valley.

4. Deer Lodge National Forest Multiple Use Plan (1973) describes the basic resources of the basin, including the water resources, and discusses three alternatives related to use of forest land within the basin.

5. Headwaters Resources, Conservation and Development Project Plan, U.S.D.A., Soil Conservation Service (no date) describes the natural resources of a very large area in the upper portion of the Clark Fork and the Jefferson River drainage system. The plan discusses a variety of actions related to soil and water conservation practices within the drainage and discusses the impact of these actions upon the area.

6. A Water Quality Study of the Upper Clark Fork River and Selected Tributaries, Environmental Protection Agency (1972) examined the water quality and biological conditions in the Clark Fork River between Warm Springs and Drummond, Montana, and discussed the problem of allowable concentrations of metals and other constituents that would be allowable in the river. The conclusions

were that the Clark Fork River at Deer Lodge was severely polluted due principally to the waste discharges from the Anaconda Company. The river improves in its biological and chemical condition downstream and becomes relatively healthy in the vicinity of Garrison.

7. Rock Creek Fisheries Habitat and Water Quality Study, U. S. Forest Service (1974) examined the intergravel, dissolved oxygen and permeability readings in Rock Creek and discussed the impact of suspended solids on intergravel movements.

8. Dissolved Oxygen and Temperature Diurnal Variations in the Clark Fork River Between Deer Lodge and Superior, Montana, by R. D. Braico (1973) discussed temperature, dissolved oxygen and metals in the Clark Fork River and the impacts of these parameters on aquatic animals.

9. Hydrogeology of the Upper Silver Bow Creek Drainage by Botz (1969) discussed the geology and groundwater conditions in the Upper Silver Bow Creek drainage in the vicinity of Butte, Montana, and concluded that groundwater was relatively abundant and of a good quality.

10. Water Quality Study of Clearwater River and Selected Tributaries by the Lolo National Forest (1973) concluded water quality is poorest during the early spring runoff and improves throughout the summer. There is a definite relationship between land use practices in the drainage and water quality. Generally, water quality of streams in the area studied was good.

11. Detrimental Effects of Highway Construction on Montana Streams by Whitney and Bailey (no date) examined the impact of highway construction on the productivity of Flint Creek and concluded that the construction reduced the number and size of fish in the area impacted by the highway.

12. Water Resources of the Upper Blackfoot River Valley, West Central, Montana, U.S. Geological Survey, Coffin and Wilke (1971) examined the general hydrogeological conditions in the Upper Blackfoot River, particularly with respect to a proposed mining development in that drainage.

13. Influence of Industrial, Municipal and Private Wastes on Water Quality in the Upper Clark Fork Drainage, A Reconnaisance Study by Miller, Higgins, and Bond (1974) presented background data with respect to the quality of Silver Bow Creek above the Warm Springs pond system including tributaries of this stream. Major constituents and metals were analyzed at numerous locations at frequencies that varied from bi-weekly to semi-annually. The objective of the study was to identify and investigate potential pollution sources and determine the physical, chemical, and biological conditions present in the basin. A portion of this

report was devoted to a study of the impact of mining wastes present in the Silver Bow Creek channel on relatively high quality waters that would be discharged by the Anaconda Company after completion of their waste treatment system. It was concluded that toxic metals can be leached from wastes that border Silver Bow Creek and can re-enter the creek to cause water quality degradation.

14. Heavy Metal Concentration in Fish Tissue of the Upper Clark Fork River, VanMeter (1974) involved a number of streams in the Upper Clark Fork River basin, results of which indicated that parts of the Flint Creek drainage contained elevated concentrations of mercury and elevated levels of cadmium were found in fish in the Little Blackfoot River.

15. Microinvertebrates of the Clark Fork River, Montana, Montana State Board of Health and Montana State Fish and Game Department (1961) showed that the Upper Clark Fork River was in rather poor biological condition due to mine-mill wastes and domestic wastes. It also indicated that during low water periods, the main stem of the Clark Fork River is affected by Missoula sewage. Below the mouth of the Bitterroot River, the main stem of the Clark Fork appears to be in good biological condition.

16. Ecological Studies of Silver Bow and Blacktail Creeks and Upper Clark Fork River, Gless (1973) investigated the existing bacterial and invertebrate ecosystems examined in 1972 and 1973. A number of point sources of fecal contamination were noted in the drainage. The invertebrate studies indicated some streams were of high quality and some streams, the invertebrate populations were severely inhibited by waste effluents.

17. Management Alternatives, Placid-Blanchard Planning Unit, Lolo National Forest (1973) described the physical resources of the basin, including the aquatic habitat and management alternatives.

18. Geology and Groundwater Resources of the Deer Lodge Valley, Montana, U. S. Geological Survey (1968) describes the hydrogeological conditions of the Deer Lodge Valley. This investigation dealt very little with water quality but established the basic hydrogeological framework that controls water quality.

19. The Montana Fish and Game Department issues periodical reports describing waters in Montana. A report has been issued describing the waters of the Clark Fork River drainage, and the report dealt primarily with the fishery in the Clark Fork River below the Hoerner Waldorf plant and Flint Creek and in the Georgetown Lake and the Clark Fork River main stem. The report principally talked about fish populations and factors in the drainage that influenced fish populations.

20. In 1970, a comprehensive series of areawide water and sewer plans

were developed by the state of Montana for each county in Montana. The purpose of these plans was to analyze the present state of water supply and sewage disposal and is based on projected changes in population, economy, and land use. Alternative sources of water and methods of waste disposal are described. A general physical description of the counties is included. The reports contain excellent information on the sewer and water systems in each of the county communities.

21. Flood plans and streams in the Upper Clark Fork River drainage are in the process of being delineated by the Department of Natural Resources and Conservation. A Type IV study is in progress in the Upper Clark River drainage. This project started in 1972 and will conclude in 1976. The effort is in cooperation with the planning units of the U. S. Department of Agriculture and other state agencies to assess land and water resources, identify needs and opportunities in the basin, and provide background to the Montana state water plan. This effort will include a discussion of the basic water quality framework in the basin.

22. The EPA, in the summer of 1974, conducted a study of plant growth in the Clark Fork River from Deer Lodge downstream to the Blackfoot River. A significant increase in algae was observed in this segment and the study was designed to determine the cause of this algal problem.

23. Wright (1974) examined the aquatic ecosystem associated with Georgetown Lake to determine the impact of accelerated land development peripheral to Georgetown Lake on the aquatic organisms in the lake, particularly the aquatic plants.

24. Rock Creek II by Streebin (1972) is a continuation of the 1970 Rock Creek Water Quality Study conducted by the University of Oklahoma. These two reports studied the water quality of Rock Creek, and it was concluded that the water of Rock Creek is of high quality with low concentrations of nutrients and organic substances.

25. Water Quality Survey by Streebin, 1972, dealt with six different watersheds, two of which are in the Upper Clark Fork basin--Monture Creek and Clearwater River. Results of the study indicate these waters to be of excellent quality. Variation in concentration of most parameters were attributed to topography and/or geology with land use playing a lesser role. Recommendations were made to help in planning follow-up studies and similar future studies.

FEDERAL PLANNING EFFORT

The Headwaters Resource Conservation and Development Project located along the Continental Divide in southwestern Montana includes seven counties. Madison, Beaverhead and Jefferson Counties lie entirely in the Missouri River drainage, but Powell, Granite, Deer Lodge, and Silver Bow Counties lie entirely in the Clark Fork basin or straddle the Divide between these two major river basins. Project objectives are to expand economic and social opportunities, promote good land use policy, encourage the multiple use concept of resource development, and develop the multiple use concept of resource development. The project is privately motivated and operates with the assistance of the U.S. Department of Agriculture, Soil Conservation Service. Technical assistance is also supplied by other agencies of federal, state, and local government.

A flood plain hazard report for the Clark Fork River above Missoula in Missoula County has been completed by Robert J. Wheeler at the University of Montana. The Army Corps of Engineers and the Montana Department of Natural Resources and Conservation have completed a flood plain study on Cottonwood Creek in the Deer Lodge city limits. The cities of Butte, Anaconda, and Deer Lodge have Department of Housing and Urban Development flood hazard maps, and Butte is participating in the Federal Flood Insurance Program.

The Montana Department of Natural Resources and Conservation, in cooperation with the Soil Conservation Service, Forest Service, and Economic Research Service of the U.S. Department of Agriculture, is presently conducting a Type IV river basin survey of the entire Clark Fork River basin in western Montana. The Type IV survey is basically of reconnaissance level (similar to Level B) but more oriented to USDA programs.

The purpose of this survey is to outline a coordinated and orderly program for the conservation, development, utilization, and management of the water and related land resources of the basin. The program will outline the role of the U.S. Department of Agriculture in cooperation with the other federal, state, and local agencies. It will also define the role of the Water Resources Division of the Montana Department of Natural Resources and Conservation in achieving optimum use and development of the basin's natural resources as part of the state water planning program.

The study, begun in 1972 and scheduled to be completed in 1976, will identify the problems and needs of the basin and the opportunities of USDA programs to solve problems and meet the needs of the present and future. This data will be used in multi-objective planning for the development and use of natural resources. Local organizations will be encouraged to sponsor the development of identified alternatives under the programs of participating federal and state agencies.

AREAWIDE WASTER TREATMENT AND MANAGEMENT PLANS

There are no areawide waste treatment management plans in the Upper Clark Fork basin encompassed under Section 208 of the Federal Water Pollution Control Act Amendments of 1972. There has been recent interest (January 1976) from several counties in the Upper and Lower Clark Fork Basins to jointly request area designation for Section 208 planning.

SECTION 201 FACILITY PLANS

No wastewater facility plans have been completed for municipalities in the Upper Clark Fork River basin as of March 14, 1975. However, the Butte Metro Sanitary and Storm Sewer District No. 1 has completed a 201 plan with grant assistance. This plan is under revision. Anaconda-Opportunity and Warm Springs are now preparing 201 plans without grants. These communities, along with Lincoln, Deer Lodge, and Drummond are on a priority list to receive future grant assistance.

IV. BASIN PHYSICAL CHARACTERISTICS

The Upper Clark Fork basin is located in west-central Montana, and comprises approximately 6,000 square miles of land which includes all of Granite County, portions of Powell, Missoula, Lewis and Clark, Deer Lodge, and Silver Bow Counties (Plate I). The Continental Divide forms the basin's northeastern, eastern and southern borders. Most of the western border is the Divide of the Sapphire Mountains, and a portion of the northern border extends to the southern end of the Mission and Swan Mountains. The Flint Creek Range and Garnet Range lie within the basin. These heavily forested mountain areas, along the borders and interior, comprise a majority of the total land area of the basin. Agricultural lands are situated in valleys where climate and terrain are suitable.

Major drainages in the basin are the Clark Fork River and its headwaters, Flint Creek, Rock Creek, Blackfoot River, and Clearwater River drainages. There are six municipal waste dischargers, six industrial waste dischargers, two permanent water quality monitoring stations, 13 streamflow gauging stations, and nine weather stations in the basin (Plate I). All surface waters within the Upper Clark Fork basin have been classified by the State of Montana according to use and existing quality. Most waters in the basin have been classified as B-D_1 by the State of Montana. Water of this classification is to be maintained suitable for drinking, culinary and food processing purposes after adequate treatment equal to coagulation, sedimentation, filtration, disinfection, and any additional treatment necessary to remove naturally present impurities; bathing, swimming, and recreation; growth and propagation of salmonoid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.

Clark Fork River (main stem) from Cottonwood Creek to the Little Blackfoot River is classified C-D_1. The Clark Fork River main stem from Warm Springs Creek to Cottonwood Creek is classified C-D_2. With the C-D_1 classification, water quality is to be maintained suitable for bathing, swimming, and recreation; growth and propagation of salmonoid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply. C-D_2 water is to be maintained for bathing, swimming and recreation; growth and marginal propagation of salmonoid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.

Yankee Doodle and Basin Creek drainage to and including the Butte water supply reservoir, Tin Cup Joe Creek drainage to the Deer Lodge water supply intake, and Fred Burr Lake and headwaters from source to the outlet of the lake are classified A-Closed. A-Closed waters are to be maintained suitable for drinking, culinary and food processing purposes after simple disinfection. Public access and activities, such as livestock grazing and timber harvest, are

controlled by the utility owner under conditions prescribed and orders issued by the department.

Silver Bow Creek is classified as an E-F stream which means that the water must be maintained for agricultural and industrial uses other than food processing.

Georgetown Lake and tributaries above Georgetown Dam, and South Boulder Creek drainage to the Philipsburg water supply intake are classified A-Open-D_1. A-Open-D_1 waters are to be maintained suitable for drinking, culinary and food processing purposes after simple disinfection and removal of naturally present impurities; all other criteria are the same as for B-D_1. All other surface waters in the basin are classified as B-D_1. Montana's water quality standards for state waters is in Appendix B.

CLIMATE

Climatic conditions in the Upper Clark Fork River basin vary greatly due to wide variations in topography. There are climatic differences between the high mountain areas and lower valleys. Valley climate is characterized by relatively dry weather during the colder months. Approximately 75 percent of the annual precipitation falls during late spring and early summer. Winters are relatively cold, with the coldest month being January. Summers are pleasantly warm, averaging between 60°F and 65°F in July. Occasionally, summer temperature may get over 90°F, but hot daytime temperatures are usually followed by cool night temperatures (Water Resources Survey, Powell County, June, 1959).

The climate of high mountain areas is characterized by colder average temperature and heavier precipitation, mainly in the form of snow. The heaviest precipitation occurs from mid-winter to early spring. Mountain snowpacks are the basin's major water source during the late spring and summer months.

Operating weather stations in the basin are listed in Table 1. The stations listed are maintained by the National Oceanographic and Atmospheric Administration (NOAA), private individuals, private industry, or other governmental agencies under cooperative agreement with NOAA. Basin weather can be characterized by data collected at Butte and Missoula. Although Missoula is not within the Upper Clark Fork basin it is very near the basin and typifies weather in the northern portion of the basin. Normal monthly temperatures and precipitation for Butte and Missoula from 1931 to 1960 are shown in Figure 2.

TABLE 1. WEATHER STATIONS IN THE UPPER CLARK FORK BASIN

Station Name	Years of Record Temp.	Years of Record Precip.	Average Annual Temperature °F	Average Annual Precipitation Inches
Butte FAA Airport	74	79	38.7	11.48
Deer Lodge 3W	13	14	41.8	7.99
Drummond Aviation	11	11	43.1	9.01
East Anaconda	66	68	42.8	13.22
Elliston	22	22	39.8	11.34
Lincoln Ranger Station	12	23	41.2	12.26
Ovando	61	74	39.3	15.95
Philipsburg Ranger Station	61	68	41.2	14.97
Seeley Lake Ranger Station	34	34	41.9	14.68
Silver Lake	-	24	-	18.69

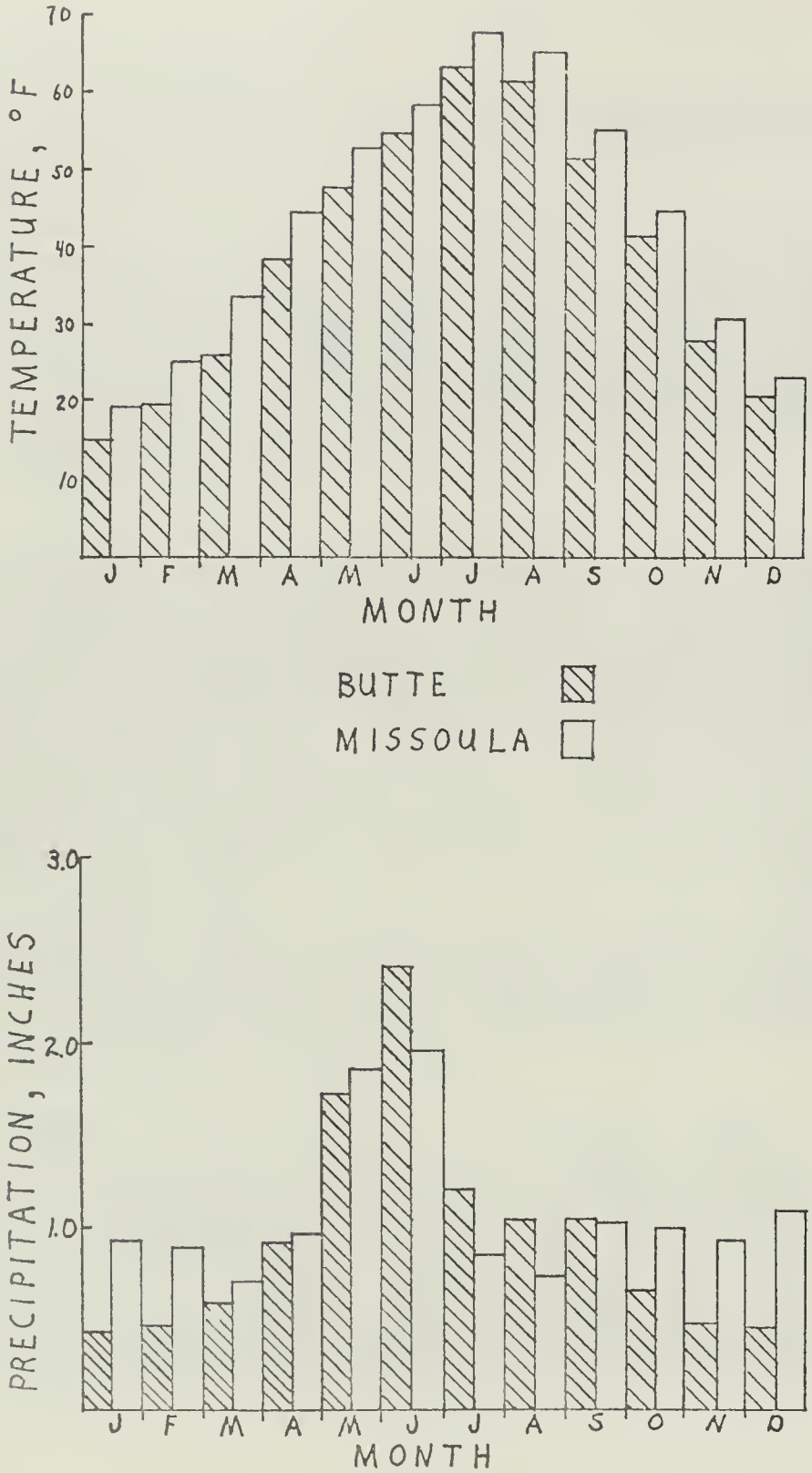


FIGURE 2. AVERAGE TEMPERATURE AND PRECIPITATION FOR TWO REPRESENTATIVE CITIES IN THE UPPER CLARK FORK BASIN
(Based on NOAA data from 1931 to 1960)

HYDROGEOLOGY

Groundwater is extensively used in the Upper Clark Fork River basin, primarily for domestic and stock use, and to a lesser extent for irrigation, public water supply and industrial purposes. Groundwater is widely available in the basin and constitutes a valuable basin resource. The availability, distribution and quality of groundwater is directly related to the geological history of the area. This history includes long periods of sedimentation, extensive structural deformation, implacements of large igneous masses, erosion, mountain building, and glaciation.

Rocks exposed in the basin vary greatly in age, lithology, thickness and aerial distribution. The oldest rocks in the basin are Precambrian in age (over 600 million years old) and consist of a thick section of argillite (slightly metamorphased shale), quartzite, and carbonate deposits. Overlying the Precambrian rocks is another moderately thick sequence of sedimentary rocks (limestone, shale, and sandstone) of Paleozoic Age (225 million to 600 million years old) and Mesozoic (70 million to 225 million years old) Age. At the end of Mesozoic time, much of the basin was uplifted, faulted, folded, and eroded. Implacement of large masses of igneous material (volcanic and plutonic rocks) also occurred during this same period causing extensive mineralization in some areas. Subsequent erosion has exposed many older sedimentary and igneous rocks, while deposition of fine-grained sediments occurred in many valleys and topographic lows during the Tertiary Age (one million to 70 million years ago). During Pleistocene time (15,000 to 1,000,000 years ago), numerous small alpine glaciers scoured out many valleys in mountainous areas in the basin. Continued erosion, sedimentation and development of the landscape has occurred during the last 15,000 years (Recent age).

The majority of groundwater in the basin is derived from the following aquifers (water-bearing strata):

1. Precambrian metasedimentary rocks,

2. Paleozoic and Mesozoic sedimentary rocks,

3. Igneous, plutonic and volcanic deposits,

4. Tertiary basin-fill sediments,

5. Pleistocene deposits,

6. Recent alluvial flood plain sediments.

Precambrian rocks occurred dominantly in the northern and northwestern portions of the basin. For the most part, these rocks are tightly compacted and exhibit low permeability (ability to

transmit water). In general, small quantities of water are found in wells penetrating Precambrian strata. If extensive fractured or weathered zones are encountered, larger yields are expected. Water derived from these rocks generally is excellent in quality.

Folded and faulted Paleozoic and Mesozoic sediments underlie substantial portions of the basin, particularly in the mountains west of Deer Lodge and north of the Clark Fork River between Deer Lodge and Missoula. These rocks have not been extensively developed for groundwater, but there are numerous water-bearing zones in these formations that will yield small to large quantities of water of fair to excellent quality.

Igneous rocks are abundant in mountain ranges west, east and south of the Deer Lodge Valley. In general, igneous rocks have low permeabilities and only small quantities of water can be developed from wells. These rocks are not widely used as a source of groundwater in the basin.

Tertiary sediments are exposed at the ground surface in the Deer Lodge Valley, the Flint Creek Valley, the lower portion of Flint Creek, in the upper portion of Silver Bow Creek, and in the Nevada Creek drainage. These sediments are composed of material eroded from rocks in the surrounding mountains, and some material ejected from ancient volcanos. These sediments are not extensively used as a source of groundwater; however, wells drilled into the upper few hundred feet of these sediments normally encounter small to sometimes large quantities of groundwater of fair to excellent quality. The character and thickness of Tertiary sedimentary rocks is highly variable and yields to wells are highly variable.

Deposits of glacial debris from numerous mountain glaciers are found along most of the higher mountain ranges in the basin. Adequate supplies of fair quality water can usually be obtained for domestic and stock purposes where these glacier deposits are encountered.

Recent alluvial deposits consisting of unconsolidated mixtures of clay, silt, sand, and gravel are found along floodplains of major streams in the basin. Thickness of the alluvium ranges from a few feet to many tens of feet. Abundant supplies of good quality water are obtained from wells drilled into alluvium where there is a sufficient thickness of the alluvium.

Groundwater pollution has occurred in a number of areas in the Upper Clark Fork River basin. Probably the most severe area of pollution is in the vicinity of Silver Bow Creek in Butte and near Anaconda, Montana. Effluents associated with the mining and copper producing operations in both Butte and Anaconda have percolated into the ground and have created zones of poor quality groundwater. Other groundwater pollution problems in the basin include acid mine

drainage from abandoned metal mines in the Upper Blackfoot River drainage and pollution from petroleum products in the community of Deer Lodge.

Sewage stabilization lagoons generally have seepage into the groundwater and create localized areas of groundwater pollution. However, there have been no problems due to lagoon seepage reported in the basin. Septic tank and subsurface disposal of domestic wastes can create localized areas of groundwater pollution. Where there are large numbers of septic tanks and individual water supplies using wells, groundwater pollution can occur if the systems are improperly designed and located. Such problems have tentatively been identified in the Lincoln and Lake Placid areas of the basin but have not been thoroughly investigated.

SOILS

Soils of the Upper Clark Fork River Basin vary widely in their physical and chemical properties due to the complicated geological history of the area, the diverse climatic conditions of the area, the variety of plant and animal life on and in the soil and the length of time the forces of nature have interacted. The dominant physiographic features are stream valleys bordered by high mountain ranges.

The steep high mountain peaks are dominated by shallow and very shallow soils with considerable rock outcrop. Light colored, deep loamy soils with gravelly subsoil and substratum have developed on metamorphic bedrock. Loamy, light colored soils with gravelly substratum have also developed on igneous bedrock and on glacial moraines. These soils are used for timber, range, wildlife and water production.

Loamy, dark colored grassland soils have developed on some undulating to steep glacial moraines. These are used mainly for range production. Gently sloping, deep, dark colored loamy soils have developed on terraces and moderately deep loamy soils on fans. Grazing and crop production are the principle use of these. Clayey grassland soils along with loamy surfaces, clayey subsoil and calcareous substratum can be found in the Blackfoot Valley and are used for irrigated pasture and rangeland. On the nearly level, poorly drained areas, loamy soils of varying depth have developed over sand and gravel. These soils are used primarily for hay production and pasture.

Detailed soil surveys have been made on a farm to farm basis by Soil Conservation Service technicians for conservation district cooperators. A progressive soil service has been conducted in the Summit Valley in Silver Bow County and in the areas of Granite County dominated by private land. It is intended to accelerate the program in other areas of the river basin to provide the interpretive data need for proper land management.

LAND USE

The Upper Clark Fork River basin comprises an area of 6,115 square miles or 3,913,600 acres above Missoula. The area includes all of Granite County, and parts of Deer Lodge, Silver Bow, Powell, Lewis and Clark, and Missoula Counties. Irrigated cropland covers 150,000 acres of the basin while dry cropland exceeds 23,000 acres. Forest lands cover 2.3 million acres, pasture and range 880,000 acres, urban and built-up areas 54,000 acres, and small water areas 9,700 acres.

WATER USE

The irrigation of agricultural land accounts for the largest use of water in the basin. Total diversion requirements for irrigation approach 500,000 acre feet per year with a net depletion of nearly one-half that amount. Non-irrigation water use in the basin exceeds 79 million gallons per day or nearly 89,000 acre feet per year. The largest user is industry with 58 mgd of water withdrawals, 55 mgd from surface water, and 3 mgd from groundwater.

Municipal users require 19 mgd, the majority (13.7 mgd) from surface water sources, while rural domestic and livestock users withdraw less than 2 mgd of a combination of surface and groundwater for their use. Public water suppliers in the basin are listed in Table 2.

The average annual flow of the Clark Fork at Missoula (1970) is 2,123,000 acre feet per year, much of that (1,174,000 afy) contributed by the Blackfoot River. There are 2 hydroelectric plants in the basin, Flint Creek at Georgetown Lake, and Milltown near Bonner on the Clark Fork. Combined generation capacity is only 4.1 megawatts.

TABLE 2. PUBLIC WATER SUPPLIES IN UPPER CLARK FORK BASIN

Community	Approximate Pop.Served	Source	Storage	Distribution	Problems Described
Anaconda	12,100	Hearst Lake 3 Wells Fifer Creek Warm Springs, aux	Water from Fifer Creek and Hearst Lake	Water from Fifer Cr. and Hearst Lake go to central pump house where well water comes into it.	System maintained in very satisfactory manner.
Butte	23,400	Big Hole River Basin Creek Moulton Creek	Pumped Reservoir 60 million gal. & 360 million gallon Reservoir	Pumped Gravity Gravity	No problems. Recommended west side reservoir be covered 8/24/73. Water from Divide Creek reservoir. None.
Deer Lodge (Municipal)	4,300	Tin Cup Joe Lake 2 drilled wells Infiltration well	Gravity 100,000 reservoir	Gravity Pump Pump	Supply might be augmented by old abandoned water line. Chlorination needed. None None
Deer Lodge (State)	2,000	2 drilled wells	80 ft. at 240 GPM 120 ft. at 240 GPM	Pump Pump	New well is being drilled at prison farm to augment supply.
Philipsburg	1,120	Fred Burr Lakes Frost Creek South Boulder Crk.	200,000 gal. concrete reservoir 90,000 gal. res.	Gravity 12" resin pump Gravity	Change from 8 inch to 12 incl pipe.
Ramsay	200	2 drilled wells	Storage Tank	Gravity	Equipment and maintenance fo wells is well maintained.
Seeley Lake	900	Seeley Lake	Seeley Lake	Pump facilities draw water from inlet 300 ft. from shore.	Chlorine disinfectant is introduced during pumping cycle.
Avon	220	Private Wells			Insufficient population to warrant community water syste
Drummond	600	Private Wells			It is recommended a central water system be constructed.

POPULATION AND ECONOMY

The Upper Clark Fork basin is made up of Granite and Powell Counties, half each of Deer Lodge, Missoula and Silver Bow Counties, and a small rural part of Lewis and Clark County. The largest urban center is Butte in Silver Bow County, with a 1970 population of 23,368. Butte, Anaconda (Deer Lodge County), and Deer Lodge (Powell County), are the only areas classified as urban by the U. S. Census, leaving 20,525 of the total population of 53,836 called rural. Table 3 shows the distribution in communities of 100 or more.

Both population and employment in the basin have decreased since 1930. The 1970 population is 15% less and employment 35% less compared to 1930 census data. The decrease is projected to continue through 1985 (Table 4). (Department of Natural Resources and Conservation). The rate of change in population and employment between 1930 and 1970 indicates a more independent population, probably due to a greater percentage of the population in retirement.

This basin is heavily dependent on mining as a primary source of jobs, directly responsible for 15.8% of all employment in 1970. However, this percentage is down from 1930, when mining comprised almost 25% of all employment. The decline in mining employment intensified in the winter of 1975, as the Anaconda Company announced plans to cutback 2,150 jobs. The serious national and worldwide economic recession was blamed for 1,500 of these cutbacks and 650 jobs were eliminated due to closure of Anaconda's underground mining operations at Butte (Freeman, Associated Press Writer, 1975).

Agriculture has also declined as a job-providing sector in the past 45 years, accounting for less than one-half as many jobs now as in 1930. The average size farm in the basin is under 500 acres. Livestock and livestock products account for about 80% of farm receipts.

One characteristic of the basin accounting for the high percentage of employment attributable to services as shown in Table 5, is the presence of several state institutions, including the Montana State Prison at Deer Lodge, Galen State Hospital at Galen, and Warm Springs State Hospital at Warm Springs.

Table 6 shows land use in the basin (excluding the small portion of Lewis and Clark County). The small part devoted to crops and pasture is at least partially due to the high elevation and short growing season.

TABLE 3. UPPER CLARK FORK BASIN;
COMMUNITIES OF 100 OR MORE PERSONS

Community	County	1970 Population
Anaconda	Deer Lodge	9,771
Warm Springs	Deer Lodge	500
Drummond	Granite	494
Philipsburg	Granite	1,128
Lincoln	Lewis and Clark	1,005
Bonner	Missoula	185
Clinton	Missoula	995
Seeley Lake	Missoula	800
Avon	Powell	220
Deer Lodge	Powell	4,306
Elliston	Powell	190
Garrison	Powell	150
Helmville	Powell	110
Ovando	Powell	120
Butte	Silver Bow	23,368

TABLE 4. UPPER CLARK FORK BASIN, POPULATION AND EMPLOYMENT HISTORICAL AND PROJECTED, 1930-1985

	1930	1940	1950	1960	1970	1980	1985
Population	70,953	67,564	63,421	63,517	58,836	56,725	55,742
Employment	30,903	22,484	23,546	20,563	20,105	17,885	17,102

TABLE 5. UPPER CLARK FORK BASIN, EMPLOYMENT BY GROSS SECTORS, 1970

SECTOR	NUMBER	PERCENT OF TOTAL
Agriculture	692	3.4
Forestry and Fisheries	145	0.7
Mining	3,170	15.8
Construction	1,016	5.1
Manufacturing	1,804	9.0
Services and Other	13,278	66.0
TOTAL	20,105	100.0

TABLE 6. LAND USE IN 1967; GRANITE, POWELL, DEER LODGE, SILVER BOW, AND MISSOULA[1] COUNTIES

COUNTY	TOTAL INVENTORY[2]	CROPLAND[2]	PASTURE[2]	RANGE[2]	FOREST[2]	OTHER[2]
Granite	393,685	37,092(9.4%)	11,645 (3.0%)	182,634 (46.4%)	159,411 (40.5%)	2,903 (0.7%)
Powell	759,653	71,612 (9.4%)	26,012 (3.4%)	361,697 (47.6%)	293,886 (38.7%)	6,446 (0.9%)
Deer Lodge	293,517	16,892 (5.8%)	8,293 (2.8%)	146,860 (50.0%)	119,567 (40.7%)	1,905 (0.7%)
Silver Bow	206,309	5,980 (2.9%)	2,000 (1.0%)	147,371 (71.4%)	49,490 (24.0%)	1,468 (0.7%)
Missoula	934,618	43,646 (4.7%)	14,000 (1.5%)	74,079 (7.9%)	790,303 (84.6%)	12,590 (1.3%)

(1) USDA, Montana Soil and Water Conservation Needs Inventory, 1970

(2) Expressed in acres and percent of total

V. MONTANA WATER POLLUTION CONTROL PROGRAM

INTRODUCTION

Water quality management planning is part of a broad, comprehensive water pollution control program administered by the Water Quality Bureau of the Environmental Sciences Division of the Montana Department of Health and Environmental Sciences. Details of this program are described in annual reports of the bureau. Important elements of the state program are:

1. State and federal waste discharge permit programs.

2. Water quality standards.

3. Statewide monitoring and surveillance.

4. Facilities construction grants, plan review, operation and maintenance inspections, training and licensing of operators.

5. Public participation.

6. Enforcement.

STATE AND FEDERAL WASTE DISCHARGE PERMIT PROGRAMS

The present state program of issuing waste discharge permits is operated under the authority given by the Montana Water Pollution Control Law and the Montana Pollutant Discharge Elimination System (MPDES). At the present time, the U. S. Environmental Protection Agency (EPA) is also issuing waste discharge permits in the state of Montana to federal facilities and to discharges, from other than incorporated communities, on indian reservations. The permits are being issued pursuant to the National Pollutant Discharge Elimination System (NPDES) created by the Federal Water Pollution Control Act Amendments of 1972 (FWPCAA of 1972). To eliminate the duplication of effort which formerly existed, the state of Montana applied for and received authority from EPA to issue NPDES permits in Montana. Section 402 of the FWPCAA of 1972 provides that states with adequate water pollution control programs may apply for and receive authority from EPA to issue discharge permits under the NPDES in their own states. Montana made the necessary revisions to the state water pollution control laws during the 1973 legislative session to provide statutory authority for administration of the NPDES program in Montana. The Montana Department of Health and Environmental Sciences was given the authority to administer the waste discharge permit program on June 10, 1974. Waste discharge permits issued under the NPDES prior to the MPDES permit program will serve as MPDES permit until their date of expiration. All MPDES permits issued meet the minimum requirements of the EPA for NPDES permits.

The Federal Water Pollution Control Act Amendments of 1972 established the following time schedule for upgrading waste treatment facilities:

MUNICIPALITIES

1. Secondary treatment by July 1, 1977

2. Best practical control technology by July 1, 1983.

3. No discharge of pollutants by 1985 (goal).

4. Any more stringent limitation necessary to meet water quality standards.

INDUSTRIES

1. Best practicable control technology by July 1, 1977.

2. Best available control technology by July 1, 1983.

3. No discharge of pollutants by 1985 (goal).

NATIONAL SECONDARY TREATMENT REQUIREMENTS (FWPCAA OF 1972)

Minimum five-day biochemical oxygen demand (BOD_5) reduction to 85 percent.

Minimum suspended solids reduction of 85 percent.

Maximum effluent BOD_5 of 30 mg/l on monthly average and 45 mg/l on weekly average.

Maximum effluent fecal coliform of 200 organisms/100 ml on monthly average and 400 organisms/100 ml on weekly average.

pH limits on effluent maintained between 6 and 9.

Maximum effluent suspended solids of 30 mg/l on monthly average and 45 mg/l on weekly average.

Self-monitoring of these parameters is required. The frequency of monitoring is based on the population served and the complexity of the treatment facility and is stated in the NPDES or MPDES permit. In addition, some municpal dischargers are limited for and required to monitor effluent oil and grease.

WATER TREATMENT PLANT TREATMENT REQUIREMENTS

There are no parameters specified by the FWPCAA of 1972 to be monitored for water treatment plant discharges. The following requirements are being placed on NPDES permits issued in Montana:

1. No change in operating procedures will be allowed that would

result in a less desirable discharge.

2. As soon as practicable but no later than July 1, 1977:

Total suspended solids (TSS)	<45 mg/l weekly average <30 mg/l monthly average
Total dissolved aluminum	1.0 mg/l monthly average <1.5 mg/l grab sample
pH	Maintained between 6.0 and 9.0

INDUSTRIAL BEST PRACTICABLE CONTROL TECHNOLOGY REQUIREMENTS (FWPCAA OF 1972)

Industrial waste dischargers will be required to provide the best practicable control technology currently available in treatment of their waste discharges. The parameters will be limited and monitored, and the frequency of monitoring will vary with the different types of industries. The specific parameters to be limited and monitored and the frequency of monitoring are stated in the NPDES or MPDES permit.

AGRICULTURAL TREATMENT REQUIREMENTS

The Montana Pollutant Discharge Elimination System 15-2.14 (10)-S14460 requires that the owner or operator of any point source discharging pollutants into state waters shall file an appropriate MPDES permit application. In this rule, the term "point source" includes animal confinement facilities which is defined as a lot or facility used or capable of being used for the feeding or holding of animals. The definition does not include land used for the growing of crops or vegetation for animal feeding or in other words, a pasture situation.

Applications for those facilities which contained 1,000 or more animal units on any 30 days during the previous year must follow the processing procedure as outlined in the above rule but small animal confinement facilities are processed via a shortened procedure.

The waste discharge permits issued for animal confinement facilities will generally prohibit any discharge of pollutants unless rainfall in excess of 10-year, 24-hour rainfall or equivalent moisture for that locale has been received.

Irrigation return flows will currently be subject to MPDES permit if there is a point source discharge through a man-made or man-maintained system from 3,000 or more irrigated acres. The paremeters to be monitored and the frequency of monitoring will be stated on the discharge permit. A recent court ruling may require modification of this requirement.

Irrigation return flows will be subject to MPDES permit if there is a point source discharge through a man-made or man-maintained drainage system from 3,000 or more irrigated acres. The parameters to be monitored and the frequency of monitoring will be stated on the discharge permit.

WATER QUALITY STANDARDS

Water pollution control started in Montana in 1907 with passage of legislation designed to protect domestic water supplies. A more comprehensive law was passed in 1955 that dealt with control and protection of water for recreation, agriculture, and industry. The 1955 law also established a water pollution control council and charged it with the tasks of classifying all streams in the state according to their most beneficial uses and establishing water quality criteria for the streams. The 1955 law also involved upgrading the treatment of wastes going into the streams. Montana thus became one of the first states to have enforceable stream classifications.

In 1965, the U. S. Congress passed the Federal Water Quality Act which required that all states classify and establish water quality criteria for their interstate streams by July 1, 1967. Montana revised its standards for both interstate and intrastate waters and required a higher degree of stream quality than before. Secondary treatment or the equivalent was required of municipal and industrial discharges. In October, 1972, the Federal Water Pollution Control Act Amendments were passed expanding the authority of the Environmental Protection Agency. Uniform water quality standards and enforcement procedures throughout the United States became the objective. Montana revised its water quality standards and adopted these revised standards on July 13, 1973. The new standards became effective in November, 1973.

Montana water quality standards serve as a functional tool in protecting water quality; however, a number of laws, statutes, and regulations complement the water quality standards and significantly assist in protecting water quality.

STATEWIDE MONITORING AND SURVEILLANCE PROGRAM

Prior to 1972, Montana had done little water quality monitoring due to inadequate funding. With increased appropriations provided by the 1971 legislature and the federal government, the state greatly increased its effort. Personnel were added to the staff, and laboratory capabilities were expanded. The present state monitoring program includes compliance monitoring of point sources of wastes including monitoring of municipal and industrial wastes, long-term baseline monitoring of streams, and a statewide program for determining the general quality of all significant surface waters.

The statewide inventory of water quality will identify areas with water quality problems and will provide basic data for water quality management and planning programs. Included in the monitoring is a statewide assessment of the trophic (pollution level) status of Montana's lakes, reservoirs, and ponds. This program is coordinated with the EPA National Eutrophication Survey.

FACILITIES CONSTRUCTION, OPERATION, AND MAINTENANCE

A minimum requirement of primary treatment for all domestic sewage was first adopted by the Montana Board of Health in 1952. All of Montana's communities have met this requirement, and many of the communities are upgrading their facilities to secondary treatment or are in the process of constructing or planning secondary treatment systems. Since 1956, there has been a federal grant program to assist municipalities in the construction of sewage treatment facilities, including outfall and interceptor sewers. In 1971, the Montana state legislature appropriated $4,000,000 to aid municipalities in construction of these same facilities. The 1973 legislature appropriated $1,600,000 to reimburse municipalities that had proceeded with construction since July 1, 1966, without waiting for state grants. With passage of the Federal Water Pollution Control Act Amendments of 1972, 75 percent of eligible project costs are federally financed. Due to a shortage of federal grant funds, a priority system for allocation must be used. The state, under EPA guidance, establishes priorities for proposed waste treatment projects.

An important part of municipal sewage treatment is proper operation and maintenance of facilities after construction is completed. In an effort to improve operation and maintenance, the state has conducted an operators' school each year. During recent years, this school has had about 100 operators attending. In 1971, a grant was obtained from the federalgovernment for employing two training instructors to establish training programs throughout the state. This activity is in addition to the annual school.

An operators certification program was established in 1968 following enactment of a law requiring certification of those responsible for the operation of sewage treatment or industrial waste treatment systems.

PUBLIC PARTICIPATION

Public participation in the water pollution control is an increasingly important aspect of the state program. Public hearings are held concerning proposed regulations, water quality management plans, and waste discharge permit applications. The state also has an environmental impact statement requirement. These statements are presented to the public for comment, and hearings are conducted on highly controversial issues.

The public also is kept informed by means of a water pollution control advisory council which has been established by law to assist the Water Quality Bureau in preparation of rules and regulations and dissemination of information to interested groups. Similarly, public meetings are attended on request, and a quarterly newsletter is published by the Water Quality Bureau.

ENFORCEMENT

Montana's laws on water pollution basically state (1) it is unlawful to cause pollution or place materials in a location where they are likely to cause pollution of state waters, and (2) discharge of waste material into state waters without a permit from the Department of Health and Environmental Sciences. Two administrative rules have been adopted by the Board of Health and Environmental Sciences which are the chief elements in Montana's water pollution control program. Montana's water quality standards serve as the primary means for defining pollution, and the Montana Pollutant Discharge Elimination System rule provides the mechanism for authorizing and controlling point source discharges to state waters. Violators of the law, a rule, permit, or order could be subject to injunction, civil penalties up to $10,000 for each day of violation, or criminal penalties with fines not to exceed $25,000 per day of violation and/or imprisonment for not more than one year for an initial conviction and not more than $50,000 per day of violation and/or imprisonment for not more than two years for subsequent violations. Significant steps were taken in 1974 to establish a workable enforcement program, including allocation of technical staff.

VI. WATER POLLUTION SOURCES

INDUSTRIAL DISCHARGES

There are 6 industrial discharges in the basin.

Table 7 lists each of the industrial waste treatment systems and their facility needs.

ANACONDA COMPANY, BUTTE

This facility is a mining and ore processing unit. Until recently, the mining consisted of underground mines and two open-pit mines. Presently, the underground mining operation is not economical and has been halted. The Butte operation produces copper ore, ore concentrate, and copper precipatate all of which is sent to the facility in Anaconda for further refining. The major recoverable metal is copper, however, lead, zinc, manganese, silver and gold are also recovered in small quantities. Until December, 1974, two discharges existed at the Butte operation. They were discharge 001 (discharge numbers refer to NPDES system), which included process water flowing into the Butte Metro storm sewer north of U. S. Highway 91 and then into Silver Bow Creek. Discharge 004, which consisted of a concentrator effluent that flowed into Horse Canyon south of the concentrators and north of Continental Drive. Water in Horse Canyon runs into the Metro sewer, which flows into Silver Bow Creek. In the middle of December, discharge 004 was discontinued and all process water is discharged through 001 except during emergency situations. Quality characteristics of discharges 001 and 004 are described in Table 8. In August of 1974, the Butte operation received a discharge permit for the Continental East Pit in Butte. The facility is an open-pit mine from which copper ore is extracted. The ore is hauled to a railroad carloading facility and then shipped to the Anaconda reduction department for processing. The discharge consists of natural precipitation and seepage water that collect in the open pit (quality shown in Table 9). Water collected in the pit is pumped to storage tanks for road dust suppression. Excess water flows to a chemical feed and mixing basin followed by settling ponds. The supernatant from the settling ponds is decanted and discharged to the Horse Canyon and then flows into Silver Bow Creek via the Metro storm sewer. The discharge will probably be eliminated in 1975 at which time, Anaconda states that the Continental East Pit will be discontinued.

ANACONDA COMPANY METALLURGICAL DIVISION, ANACONDA, MONTANA

The Anaconda Company Metallurgical works at Anaconda produces copper anodes. Raw materials consist of copper ore from the Butte operations, copper concentrates from the Weed concentrator at Butte, and copper precipitates from the precipitator plant at Butte. The copper ore is crushed at the East Anaconda crusher and

TABLE 7. INDUSTRIAL WASTE TREATMENT SYSTEMS IN THE CLARK FORK RIVER BASIN

Entity	Type of Waste	Type of Facility	Needs
Anaconda Company (Continental East Pit), Butte, Montana	Copper mining	Settling pond with lime feed for pH control.	Discharge to be eliminated in 1975.
Anaconda Company, Butte, Montana	Copper mining, concentrator and precipitator operations	Tailings ponds, pH control and recycle. Final treatment in Warm Springs ponds.	Emergency ponds to treat spills at Butte. Control of pond seepage at Warm Springs.
Anaconda Company Metallurgical Division, Anaconda, Montana	Copper smelter and concentrator wastewater	Settling ponds, pH adjustments and metal removal in Warm Springs and Anaconda pond systems.	Control pond seepage.
U. S. Plywood, Bonner, Montana	Wood by-products, domestic, cooling water	Log pond containing miscellaneous plant discharge with seepage to river, two activated sludge package plants for domestic wastes.	Eliminate temporary cooling water discharge.
Stauffer Chemical, Ramsay, Montana	Elemental phosphorus	Primary clarifier and treatment pond.	Discharge eliminated as of April 1, 1975.
Butte Water Co., Butte, Montana*	Backwash from filters	Potable water treatment plant.	Undetermined.
CMSTP and PRR, Deer Lodge, Montana	Discharge from oil separator	Oil skimming facility.	Undetermined.
Anaconda Washoe Fish Hatchery, State F & G	Circulation water from fish hatchery	Fish hatchery.	Undetermined.
Garrison, Burlington-Northern	Domestic sewage	Septic tank and drainfield.	None - no discharge.

*This facility is not physically located in the Upper Clark Fork basin.

Table 8. DISCHARGE CHARACTERISTICS OF ANACONDA COMPANY BUTTE OPERATIONS
(Anaconda Company MPDES self-monitoring data accumulated during 1974)

DISCHARGE 001

Parameter	Mean	Range	Months Sampled
Flow - mgd[1]	6.9	0 - 16.2	7
pH	9.5	3.4 - 12.2	7
Total suspended solids - mg/l	2.6	2. - 130	7
Bicarbonate alkalinity - mg/l	not measured		
Carbonate alkalinity - mg/l	31	12 - 136	6
Total hardness - mg/l as $CaCO_3$	1470	53 - 2660	6
Sulfate - mg/l	1520	1360 - 1760	5
Iron - mg/l	.18	.03 - 2.0	7
Copper - mg/l	.11	0.02 - 0.89	7
Zinc - mg/l	.18	< 0.01 - 1.6	6
Lead - mg/l	0.03	< .001 - 0.06	6
Arsenic - mg/l	0.01	.001 - 0.014	5
Cadmium - mg/l	.005	< .001 - .008	6

(1) Total average flow from discharge 001 and 004

Table 8. (continued)

DISCHARGE 004[1]

Parameter	Mean	Range	Months Sampled
Flow - mgd[2]	6.9	0 - 16.2	7
pH	9.5	3.4 - 12.4	7
Total suspended solids - mg/l	11	< 2 - 64	6
Bicarbonate alkalinity - mg/l	not measured		
Carbonate alkalinity - mg/l	15	0 - 61	6
Total hardness - mg/l as $CaCO_3$	2040	1750 - 2850	6
Sulfate - mg/l	2020	920 - 2170	6
Iron - mg/l	.11	.04 - .56	7
Copper - mg/l	.05	.02 - .15	7
Zinc - mg/l	.07	0.01 - .68	7
Lead - mg/l	.001	.01 - .06	6
Arsenic - mg/l	.001	< .001 - .004	5
Cadmium - mg/l	.008	.006 - .012	6

(1) Discontinued except during emergency conditions

(2) Total average flow from discharge 001 and 004

Table 9. DISCHARGE CHARACTERISTICS OF ANACONDA COMPANY CONTINENTAL EAST PIT
(Anaconda Company MPDES monitoring data accumulated during second half of 1974)

DISCHARGE 001

Parameter	Mean	Range	Months Sampled
Flow - mgd	0.066	0.052 - 0.122	3
pH	8.12	7.2 - 11.85	3
Total suspended solids - mg/l	9.7	<2 - 26	3
(1) Bicarbonate alkalinity - mg/l	22	12 - 32	1
Carbonate alkalinity - mg/l	29	12 - 43	1
Hydroxide alkalinity - mg/l	23	- -	1
(1) Total hardness - mg/l as $CaCO_3$	820	340 - 2,180	1
Iron - mg/l	0.30	0.1 - 0.46	2
(2) Copper - mg/l	0.51	0.18 - 0.84	2
Zinc - mg/l	0.32	<0.01 - 0.82	2
Lead - mg/l	0.018	<0.01 - 0.04	2
Cadmium - mg/l	0.04	<0.01 - 0.06	2
(2) Arsenic - mg/l	0.002	<0.001 - 0.002	1

Table 10. DISCHARGE CHARACTERISTICS OF ANACONDA COMPANY WARM SPRINGS PONDS (Anaconda Company MPDES self-monitoring 1974 data and WQB compliance monitoring data)

DISCHARGE 001

Parameter	Mean	Range	Months Sampled
Flow - mgd	0.44	0 - 0.46	2
pH	8.3	7.2 - 9.4	2
Turbidity - FTU	8.5	2.7 - 33	2
Iron - mg/l	0.65	0.9 - 2.5	2
Copper - mg/l	0.06	0.03 - 0.27	2
Zinc - mg/l	0.38	0.05 - 1.61	2
Lead - mg/l	0.08	<0.01 - 0.06	2
Mercury - ug/l	0.03	<0.02 - 0.83	2

DISCHARGE 002

Parameter	Mean	Range	Months Sampled
Flow - mgd	55	38.3 - 78	7
pH	8.3	7.11 - 9.5	7
Iron - mg/l	0.33	0.2 - 0.64	7
Copper - mg/l	0.09	0.03 - 0.1	7
Lead - mg/l	0.02	0.01 - 0.04	7
Arsenic - mg/l	0.008	.001 - 0.01	7
Mercury - ug/l	0.093	.02 - .8	7
Zinc - mg/l	0.13	0.06 - .19	7
Cadmium - mg/l	0.006	0.003 - 0.01	7

concentrated in the facilities at the smelter complex. The Anaconda Company intends to shut down its ore concentrator in 1975 in two stages. A part was closed in March and the remainder will be closed near the end of the year in conjunction with the close down of the Continental East Pit.

At present, a majority of the wastewater from the Anaconda operation emanates from the copper concentrator flotation cells. Some wastewater also comes from a smelter slag granulation overflow. Process water also is discharged from the acid plant and the lime plant. Non-process cooling water from the new arbiter plant and slaked lime used for pond pH control also are included in the discharge. On July 3, 1975, the Anaconda Company announced the closure of the arbiter plant effective July 7, 1975. The earliest reopening would be the spring of 1976. The Opportunity pond system is used for the treatment of the water from the Anaconda operation as well as municipal sewage from the City of Anaconda. Decant towers allow the discharge from the Opportunity ponds to reach the Warm Springs settling ponds. Slaked lime is added to Silver Bow Creek water just prior to its entering the Warm Springs ponds. The high pH allows metal hydroxides to precipitate in the ponds. The primary settling pond discharge is from Pond 2 (discharge #002) and discharge from Pond 1 (discharge #001) is an intermittent discharge occuring during winter months. Characteristics of discharge 001 and 002 are given in Table 10. There has been no discharge from Pond 3 (discharge #003) during the past year. Discharge 003 is an emergency discharge. It is seldom used except during emergencies.

U.S. PLYWOOD, BONNER, MONTANA

U.S. Plywood consists of a lumber operation and plywood plant. During the spring of 1974, a mechanical debarker was installed. Since that time, there has been no industrial discharge from the plant. The only industrial water reaching the Clark Fork River is log pong discharge. There are two activated sludge package plants which are used to treat the sanitary sewage (Table 11). These discharge to the Clark Fork River.

TABLE 11. DISCHARGE CHARACTERISTICS OF U. S. PLYWOOD
(WQB Compliance Monitoring Data, February 27, 1975)

Discharge 001 (log pond)

Flow (instantaneous)	1 cfs
pH	8.5
TSS	8 mg/l
Oil and Grease	1 mg/l
BOD_5	$<$24 mg/l

Discharge 002 (sanitary sewage)

Flow (instantaneous)	3 gpm
pH	7.1
TSS	2 mg/l
Fecal Coliform	$<$3/100 ml
BOD_5	24 mg/l
Residual Chlorine	1.2 mg/l

Discharge 003 (sanitary sewage)

Flow (instantaneous)	0.06 gpm
pH	8.5
Fecal Coliform	$<$30/100 ml
BOD_5	$<$ 24 mg/l
Residual Chlorine	0.3 mg/l

BUTTE WATER COMPANY

This facility is located on the South Fork of Divide Creek, which is in the Upper Missouri Basin; however, the facility provides 60 percent of the domestic supply for the Butte area and is, therefore, discussed in this report.

Raw water is obtained from the Big Hole River and pumped ten miles through a conduit to the settling and filtration plant. Chemical coagulants are only used during spring runoff. The filters are used year-round; however, backwashing is only necessary when chemicals are used, usually three to four weeks per year, once per week. The discharge passes through two settling ponds and a 2,500 foot ditch before entering Divide Creek (a tributary of the Big Hole River). Most of the discharge is lost to evaporation or seepage and very little effluent actually directly reaches the creek.

WASHOE PARK FISH HATCHERY, ANACONDA

The fish hatchery is run by the Montana Fish and Game Department of the purpose of hatching and rearing fish. The effluent is discharged to Warm Springs Creek near the city of Anaconda. The effluent characteristics of the discharge as determined by the WQB are as follows:

Flow	500 gpm (estimate)
pH	7.7
TSS	8 mg/l
BOD_5	$<$12 mg/l

Data from WQB compliance monitoring on February 6, 1975.

At the time Montana Fish Hatchery permits were drafted by the EPA, the production level at Washoe was below the minimum production level for fish hatcheries that required NPDES permits. In light of recent court decisions, it is likely a discharge permit will be required in the future.

CHICAGO, MILWAUKEE, ST. PAUL AND PACIFIC RAILROAD COMPANY, DEER LODGE

The discharge is from the engine repair shop. The effluent is treated in an oil separator before being discharged to Tin Cup Joe Creek. The discharge characteristics are as follows:

Flow	50 gpm (estimate)
pH	7.2
TSS	10 mg/l
Oil and Grease	7 mg/l

Data from WQB compliance monitoring February 6, 1975.

MUNICIPAL DISCHARGERS

Table 12 lists each community in the basin and their respective domestic waste treatment system. Of these, six discharge treated effluent to surface waters. Deer Lodge, Drummond, Warm Springs State Hospital and Galen State Hospital discharge to the Clark Fork River. Butte (Silver Bow Metro) and Anaconda discharge to Silver Bow Creek, and Philipsburg discharges to Flint Creek. Butte has an activated sludge plant, and Galen a packaged extended aeration plant. Drummond, Deer Lodge, Warm Springs and Anaconda treat their waste in lagoons. Waste discharge characteristics for all but Anaconda are listed in Table 13. Anaconda's effluent is treated along with industrial wastes in the Anaconda Company's ponds.

Sludge treatment and disposal methods for Silver Bow Metro are grossly inadequate. Metro's sludge burners are not able to handle the sludge output. Therefore, excess sludge is being dumped into Silver Bow Creek and into old tailings ponds near Anaconda. Court action has been filed by the EPA to stop the dumping of sludge into Silver Bow Creek. To date, (1-12-76) the suit is still in litigation.

Sludge treatment and disposal for Galen State Hospital consists of: 1) Removal from the digestor to drying beds; 2) Dried sludge material is transported to hay fields to be used as a soil conditioner.

Of the communities in the basin, on the statewide priority list for construction grants (Appendix D), Butte, Anaconda, Opportunity, Drummond, and Rocker are scheduled for funding in fiscal year 1976.

TABLE 12 MUNICIPAL WASTE TREATMENT SYSTEM

Entity	Type of Waste	Type of Facilities	Needs
Deer Lodge	Domestic	Lagoon, Single cell, 40 acres	Upgrading to secondary treatment.
Drummond	Domestic	Lagoon, single cell, 8 acres	Upgrading to secondary treatment.
Silver Bow Metro Butte, Montana	Domestic	Activated sludge plant	Additional sludge handling capacity.
Warm Springs State Hospital	Domestic	Lagoon, three cells, two 7 acres, one 6 acres	Upgrading to secondary.
Galen State Hospital	Domestic	Extended aeration plant	None known.
Anaconda (City of Anaconda)	Domestic	Discharge to Anaconda Company ponds where wastewater is evaporated with some seepage and outfall discharge.	Additional sewers to serve outlying areas and outfall sewer to replace ditch.
Gregson (Fairmont Hot Springs)	Domestic	Two-cell lagoon	Seal lagoon, remove excess water from lagoon system.
Seeley Lake		Septic tanks and cesspools	Central sewer system. At present, community cannot affort such a system after installation of a new water system.
Avon	Domestic	Private septic tanks and drainfields	Investigation of the adequacy of existing treatment system.
Elliston	Domestic	Private septic tanks and drainfields	Investigation of the adequacy of existing treatment system.
Garrison	Domestic	Private septic tanks, drainfields and cesspools	Investigation of the adequacy of existing treatment system.

TABLE 12 (CONTINUED)

Entity	Type of Waste	Type of Facilities	Needs
Ovando	Domestic	Private Septic tanks, drainfields and cesspools	Investigation of the adequacy of existing treatment system.
Helmville	Domestic	Private septic tanks, drainfields and cesspools	Investigation of the adequacy of existing treatment system.
Gold Creek	Domestic	Private septic tanks, drainfields and cesspools	None proposed.
Rocker	Domestic	Partial central sewage system and septic tanks and cesspools	Revise and replace existing system and construction of a stabilization pond.
Ramsay	Domestic	Central disposal system and stabilization pond.	No additional needs.
Opportunity	Domestic	Private septic tanks, cesspools and other individual means	Construction of a central sewer system.
Lincoln	Domestic	Private septic tanks and cesspools	Investigation of the adequacy of existing treatment system.
Philipsburg	Domestic	Two-cell lagoon handles both sanitary and storm sewer discharge	Possibly separating the sanitary and storm sewer system and upgrade to secondary treatment.
Hall	Domestic	Private septic tanks, cesspools and drainfields	Investigation of the adequacy of existing treatment system.
Maxville	Domestic	Private septic tanks and drainfields	None anticipated.
Georgetown Lake area	Domestic	Private septic tanks, cesspools, pit privies, and other individual systems	Construction of a central sewer system at more populated areas and upgrading of individual facilities to meet current standards.

TABLE 13. CHARACTERISTICS OF SIGNIFICANT MUNICIPAL DISCHARGES
(Self Monitoring & WQB Compliance Monitoring Data)

WASTE SOURCE IDENTIFICATION DATA						DISCHARGE CHARACTERISTICS (Units are mg/l unless otherwise shown)			
WATER SOURCE[1] AND LOCATION	TREATMENT TYPE	RECEIVING WATER	DISCHARGE PERMIT NO.	DISCHARGE TYPE	DATE SAMPLED	PARAMETER	NO. OF OBSERVATIONS	MEAN	RANGE
Deer Lodge 7N9W28DCD	lagoon	Clark Fork River	MT-0022616	continuous	Aug. 1974 - Dec. 1974	Flow (mgd) . .	12	1.40	1.00 - 2.07 MGD
						BOD_5	3	9.7	4.8 - 17.0
						TSS	1	1	
						pH	8	7.8	7.7 - 7.9
						F. Col/100 ml.	3	700	200 - 1,600
						T. Col/100 ml.	1	720	
Drummond 11N13W26AD	lagoon	Clark Fork River	MT-0020281	continuous	8-23-74 & 6-12-74	Flow	2	0.228	0.168 - 0.288
						BOD_5	1	6.9	
						TSS	1	1.0	
						pH	1	6.9	
						F. Coli/100 ml	1	18	
						T. Coli/100 ml	1	240	
Philipsburg 7N14W23CA	lagoon	Flint Creek	MT-0021903	continuous	7-15-74 - 1-1-75	Flow (mgd) . .	1	0.206	--
						BOD_5	3	13	5 - 20
						TSS	2	16.7	--
						pH	3	7.5	6.- 9.
						F. Coli/100 ml	1	10,870	--
Silver Bow Metro 03N08W23DB	activated sludge plant	Silver Bow Creek	MT-0022012	continuous	5-1-74 - 12-1-74	Flow	7	6.51	4.96 - 7.75
						pH	7	7.1	6.5 - 7.5
						BOD_5	7	12.6	9.6 -20.6
						TSS	7	12.4	2.0 -38.0
						F.Coli/100 ml.	7	1400	54 - 15,000
						T. Residual Cl_2	7	0.41	.04 - 1.0
						Temp °C . . .		13.6	11.0 - 19.0
Warm Springs State Hospital 6N9W29DB	lagoon	Clark Fork River	MT-0020010	continuous	6-1-74 - 11-30-74	Flow	42	0.436	0.279 - 0.528
						pH	42	7.9	7.8 - 8.6
						BOD_5	6	51.9	46.2 - 64.8
						TSS	4	51.2	29.0 - 70.1
						F. Coli/100 ml	4	23,000	3,700 - 40,000
Galen State Hospital 6N9W29DB	secondary sewage extended aeration plant	Clark Fork River	MT-0021431	continuous	8-1-74 - 11-30-74	Flow	continuous	0.34	0.10 - 0.54
						pH	16	7.6	7.6 - 7.6
						BOD_5.	4	14.1	13.2 - 16.2
						TSS	4	9.2	8.0 - 14.7

AGRICULTURAL WASTE DISCHARGES

Extensive information regarding agricultural waste discharges is not readily available but a variety of such discharges are known to be present within the basin. Such discharges include irrigation return flows, animal confinement facilities, and runoff from range and cultivated land. The information contained in this report has been compiled from data collected in conjunction with the Montana Pollutant Discharge Elimination System and from limited field observations. The following animal confinement facilities have received MPDES permits.

MONTANA STATE PRISON - PERMIT NO. F-13-13 ISSUED JUNE 13, 1973

The permit was issued for a proposed 900 head animal confinement facility 3.5 miles southwest of Deer Lodge, Montana. The facility is located in the NW¼, Sec. 12, T 7 N., R. 10 W., of Powell County. The applicant is required to maintain the facility so as to provide at all times storage for the runoff from a 10-year, 24-hour rainfall event from the drainage area. Storage is provided by a natural retention facility. Waste material is disposed at an adjacent agricultural land. The permit shall expire on June 13, 1978.

The parameters to be monitored in conjunction with the permits and the frequency of monitoring will be stated on the waste discharge permit.

Irrigation return flows are subject to MPDES permit requirements if there is a point source discharge through a man-made or man-maintained drainage system from 3,000 or more irrigated acres. To date, no permit applications have been received.

MINING ACTIVITY

Butte Area

The discovery of placer gold deposits in Bannack, Alder Gulch and Last Chance Gulch in 1863 caused a huge influx of people into the mountainous region of Montana. Gold was discovered in the Butte region in 1864. However, it was a lower grade than most camps in the state. Still, the area yielded about $1.5 million in gold before prospectors moved on in their restless search for new diggings. (Wigal, 1972). Between the end of the gold boom and the beginning of the silver era, Silver Bow had been a ghost town. Rocker had crumbled into decay and Butte City had dwindled to fewer than 60 inhabitants. No excitement arose over silver until the rich ore of the Travona Mine was developed in 1875. The climax of what may be called the Silver Period in Butte's history was reached in 1887 when five almalgamation mills worked over 400 tons per day of ore valued at $25 per ton. With the decline of prices in the early 1890's, the large silver plants closed and as a result, silver

declined in importance, never to again be a factor in Butte development. The Union Pacific Railroad reached Butte in 1881 and linked the area with the work markets. This marked the beginning of prosperity for the "richest hill on earth". Within a few years, five major railroads served the Butte area. In 1883, the Anaconda Company started construction on one of the world's largest copper smelters near Anaconda. It was soon too small and the Washoe Plant was built to handle the increasing load. Additional smelters were built in Great Falls and Butte. Presently, Butte mining and smelting is operated almost exclusively by the Anaconda Company. Copper ore is extracted from two open pit mines. At present copper prices, the underground operation is uneconomical but could be reopened if copper prices rose. Over 12 tons per day of concentrated ore is shipped to Anaconda for further copper refining. Other precious metals are extracted at the Great Falls refinery. Silver Bow Creek has been used as a disposal system for mining and smelting since the 1860s. As a result, it is polluted. Presently Anaconda Company is making a concerted effort to remove their industrial discharge from the creek; however, there are old tailings and other waste discharges that still introduce a heavy load of metals into the creek. Sediments along the stream also contain considerable metals, and as a result, it will probably be many years before the stream will be relatively free of substantial amounts of metal wastes.

Philipsburg Area

Mining commenced in the Philipsburg area in 1867 after the discovery of gold in the Hope Mine three years earlier. Georgetown placers and Gold Creek discoveries were worked in the same time period. The period of greatest prosperity for the Philipsburg area was from 1881 to 1893 when Philipsburg became one of the most important silver producing camps in the United States. Over the years, over $50 million in gold and silver were produced in the area (Emmons, 1913). Smelting was not feasible because the area was so remote and transportation so expensive. As a result Pan Amalgamation was used. In the process, the ore is ground and mixed with salt, mercury and copper sulfate, wherein the mercury is separated from the amalgam. At one time, there were over eight silver amalgamating mills in the Philipsburg area. Their influence on water quality is still present today. High mercury content in fish tissue and surface water in the area can be correlated directly with early day mining activities (Van Meter, 1974).

Blackfoot Area

Spence (1975) describes the mining in the Upper Blackfoot Valley. "Mining in the Upper Blackfoot Valley began about 1865. Between 1865 and 1871, about $7 million in high grade placer gold was taken from the gravels of Lincoln Gulch two miles west of Lincoln. Mining activity at the source of the Blackfoot River dates from 1889 when William Heddleston and George Padbury discovered the Calliope Lode. They built an arrastra on Pass Creek and recovered

$11,000 in gold from the Calliope Mine. Access to the Heddleston mining district was then limited to foot or horseback. Prospecting in later years produced very little gold but some amount of lead and other ores. Recovery of these metals required smelting and the Mike Horse Mill was eventually constructed on Mike Horse Creek in 1919. During the 1920's as access and transporation improved, additional quantities of lead, silver, and gold and small but appreciable amounts of copper were mined and shipped to other smelting facilities. Mining continued intermittently through World War II, especially at the Mike Horse Mine. In recent years, the Anaconda Company has discovered a porphyry copper deposit in an area near the Mike Horse Mine. There are several abandoned mineral prospects in the area, but there are no actively producing or developing mines. (Pardee and Schraeder, 1933 and Mudge, et.al, 1971). Ore drilling and tunnel exploration by the Anaconda Company have occurred during the past five years in the Mike Horse area and tunnel exploration is presently underway. Several small prospectors are also active in nearby areas."

Mine drainage has lowered water quality in the Upper Blackfoot River. Beartrap Creek below Mike Horse Mine is in poor condition. The Anaconda Company tested the water quality of the acid mine drainage in the Heddleston Mining District during the summers of 1972 and 1973. The discharge from the Mike Horse Mine tunnel completely overshadowed the combined discharges from five other tunnels checked in the area. The Mike Horse Mine had a flow of 300 gallons per minute compared with a combined flow of 57 gallons per minute in the other five tunnels. The metal load from the five tunnels was insignificant compared to the daily load from the Mike Horse Mine (Table 14).

No discharge permit or compliance schedule has been issued to the Mike Horse Mine, because the MPDES program presently does not include abandoned or inactive mines. The Mike Horse is an old inactive mine. In the future, such discharges will be considered in the MPDES program.

TABLE 14. POUNDS PER DAY OF METAL DISCHARGE FROM THE MIKE HORSE MINE.

Parameter	Daily Load (pounds)
Iron	50
Zinc	140
Manganese	75
Sulfate	2800

Sandbar Creek and Willow Creek below Sandbar Creek are also influenced by mine drainage in the area, but to a lesser degree than Beartrap Creek.

Phosphate Mining

Phosphate is mined near Garrison, Montana from the Phosphoria Formation which covers 135,000 square miles in Montana, Idaho, Wyoming, Nevada, and Utah. Like all pelletal phosphorites, the formation is marine in origin. After deposition, it was covered with a great thickness of sediments which were later lithified.

Subsequent severe regional folding and faulting left the Phosphoria Formation in all attitudes from lying flat to vertical. The present stage of erosion exposed many miles of phosphorite extending in outcrops along a 450 mile line roughly south southeastwardly from Garrison, Montana, to Vernal, Utah (Emig, 1973). The major mine in the Garrison area is the Brock (Anderson) Warm Springs Creek Mine owned by Cominco American, Inc. Most of their ore is shipped to British Columbia where it is processed into commercial fertilizer. Phosphate ore is processed at two plants in the basin. They are the Rocky Mountain phosphate in Garrison and Stauffer Chemical in Ramsay. Rocky Mountain Phosphate in Garrison produces dechlorinated phosphate which is used in feed supplement for livestock and poultry. Fluorides are driven off the phosphate rock and scrubbed out of the air with a wet scrubber system. Water and entrained fluorides are collected in a nondischarging lagoon system where lime is added to precipitate out calcium fluoride. Water is then recycled in the operation. The Stauffer Chemical Plant manufactures elemental phosphorus from ore shipped in from Idaho. This chemical is then shipped out of state as a raw material for manufacturing. Stauffer Chemical has a nondischarging lagoon system with water recycle.

NONPOINT SOURCES

Agriculture including livestock grazing and crop production, logging, mineral exploration, and mining are the major water-related land use activities in the Upper Clark Fork Basin. These are also the major nonpoint pollution sources in the basin. Agricultural practices often cause increased erosion due to alteration of streambanks and streambank vegetation. Irrigation return water and streamwater runoff increase dissolved salts and usually carry a heavy load of nutrients from fertilizers and animal wastes. Siltation, elevated water temperatures and increased nutrient loads are water quality problems normally created in surface waters in heavily logged areas. Streambank disturbance and poorly constructed roads by logging operations and mining interests have created sedimentation problems in the basin. Leaching from tailings dumps has caused heavy metal loads in the waters of some drainages.

CLARK FORK RIVER

Colorado Tailings Area - The Colorado Tailings Area is located just downstream from the community of Butte along the banks of Silver Bow Creek. A discharge draining the tailings has been found to carry a large toxic metal load into Silver Bow Creek. The influence of this tailings area as a nonpoint source has not been evaluated. The heavy metal load in Silver Bow Creek downstream of the area must certainly be due in part to the Colorado Tailings.

Opportunity and Warm Springs Ponds - Heavy metals apparently seep through the levees of the Warm Springs and Opportunity Ponds.

Downstream conductivity measurements of Warm Springs Creek and Mill Willow Creek increase sharply in the ponds area. Preliminary investigation of metal loads in the water at the lower pH shack appear higher than those of the cumulative pond load discharges, indicating substantial seepage of toxic metals through the levees.

Phosphoria Formation - Natural erosion of the Phosphoria Formation around Garrison appears to cause an increased phosphorus load in Brock and Warm Springs Creeks and there is a resultant increase in the phosphorus content of the Clark Fork River in that segment.

Willow Creek - The upper portion of Willow Creek (a tributary of Rock Creek) runs through a meadow used for ranching. Irrigation is commonly used and as a result, ammonia, alkalinity, and total dissolved solids were found to increase through the area.

Georgetown Lake - Shoreline erosion in the Georgetown Lake area is adding sediments and nutrient to the lake, thus increasing the rate of eutrophication.

BLACKFOOT RIVER

Landers Fork, North Fork - The Landers Fork and the North Fork of the Blackfoot River carry heavy sediment loads as the result of unstable banks. This may be due in part to the flood of 1964 that swept the area and changed the channel of portions of the stream and natural unstable soils upstream.

Elk Creek, Union Creek - These creeks flow through agricultural land in the lower Blackfoot Valley. Poor land use practices have reduced bank stabilization and vegetation and as a result, heavy sediment loads have been measured. High total dissolved solids measurements on the creeks are a result of irrigation return flow.

Beaver Creek - Beaver Creek carries a heavy silt load as a result of logging operations in the area.

CLEARWATER RIVER

The Clearwater River runs through flat sand-silt area between Rainy Lake and Clearwater Lake. As a result, the river picks up large quantities of suspended sediment in the area. Richmond Creek, Deer Creek, West Fork of the Clearwater River show a significant degradation in water quality as a result of logging practices in the vicinity.

VII. SURFACE WATER RESOURCES

The Upper Clark Fork basin contains five major sub-basins (Figure 1 and Plate I). These are Clark Fork River above Milltown, Blackfoot River, Clearwater River, Flint Creek and Rock Creek. The Clark Fork River and its major tributaries in the basin are shown schematically in Figure 3. The U. S. Geological Survey has had 18 stream flow gaging stations in the Upper Clark Fork basin. Thirteen of these remain active (Figure 1 and Plate I). U. S. Geological Survey data for gaging stations in the study basin are summarized in Table 15.

Stream flows in the Upper Clark Fork basin are affected by weather conditions, geology and irrigation (Table 16). A major part of the annual flow occurs during the spring runoff. However, spring runoff is a function of weather and precipitation and is variable in time and volume of runoff. March through July is the most common snowmelt period, but warm weather in mid-winter can produce significant short-term increases in stream flows. Peak flows from mountain streams, such as Rock Creek, tend to occur from mid-May through early July.

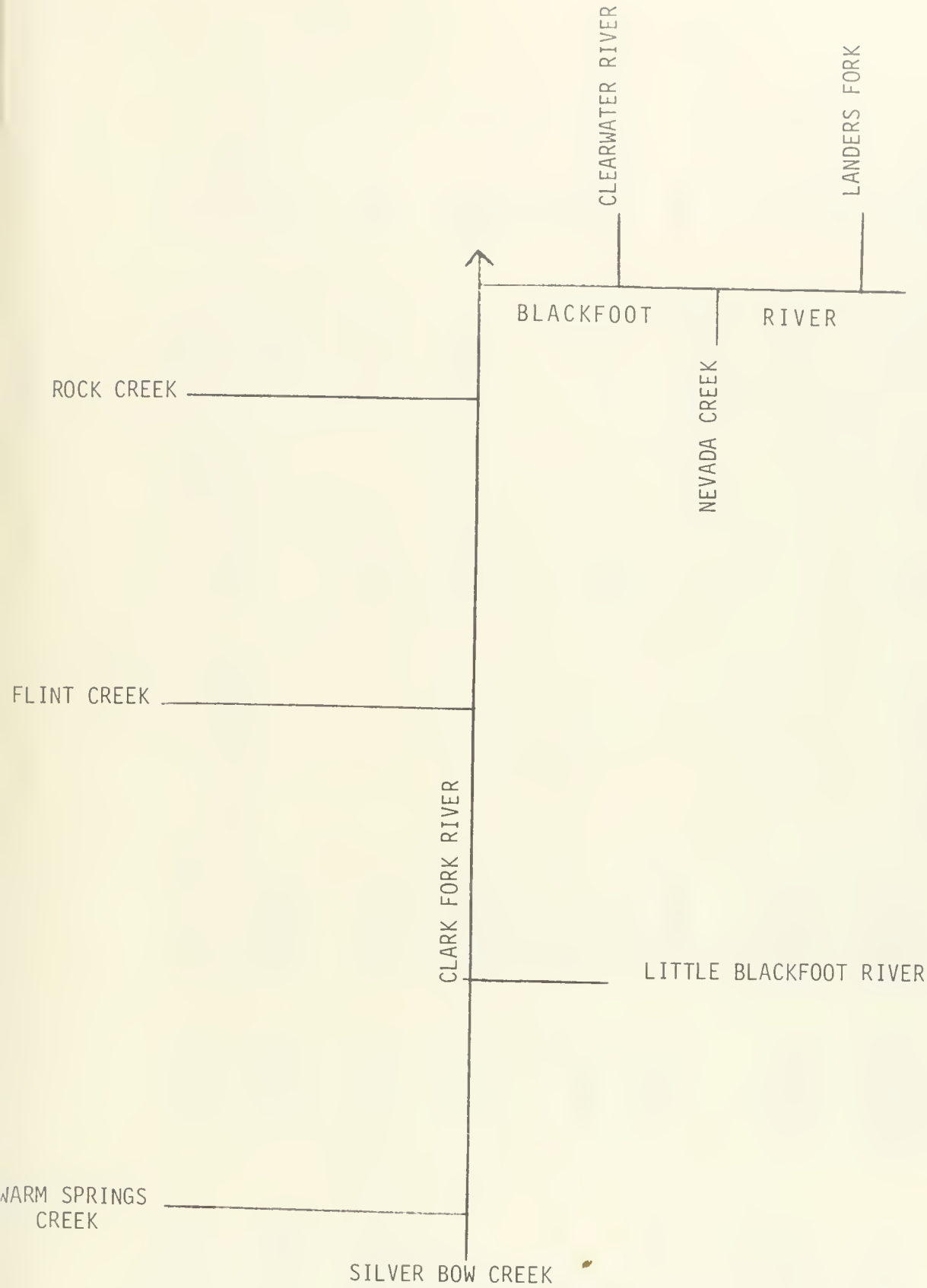


FIGURE 3. SCHEMATIC DIAGRAM OF STREAMS IN THE UPPER CLARK FORK RIVER BASIN

TABLE 15. SUMMARY OF U.S. GEOLOGICAL SURVEY STREAMFLOW GAGING STATION DATA

(Partial Record Stations Not Included)

STATION NAME	USGS STATION NO.	LOCATION(1)	MINIMUM STREAMFLOW (cfs) INSTANTANEOUS	DAILY	7-DAY, 10-YEAR, LOW FLOW (cfs)	AVERAGE ANNUAL FLOW (cfs)	PERIOD OF RECORD
Silver Bow Creek at Warm Springs, MT	12323750	5N9W18D		15		115	1972 -
Racetrack Creek below Granite Creek, near Anaconda, Montana	12324100	6N11W13AB	6.2			59.4	1957 - 1973
Flint Creek near Southern Cross, MT	12325500	6N14W36BD				28.5	1940 -
Flint Creek at Maxville, MT	12329500	8N13W9B		15		98.6	1941 -
Boulder Creek at Maxville, MT	12330000	8N13W4C	3.0			46.4	1939 -
Middle Fork Rock Creek near Philipsburg, MT	12332000	5N15W8DC		5.3		122	1937 -
Blackfoot River below Alice Creek, near Lincoln, MT	12334650	14N7W5CDD	2.3				1970 -
Nevada Creek above the Reservoir, near Finn, Montana	12335500	12N9W20	2.0			36.8	1939 -
Blackfoot River near Bonner, Montana	12340000	13N17W9BDD		200		1,637	1939 -

TABLE 15 (CONTINUED)

STATION NAME	USGS STATION NO.	LOCATION(1)	MINIMUM STREAMFLOW (cfs) INSTANTANEOUS	DAILY	7-DAY, 10-YEAR, LOW FLOW (cfs)	AVERAGE ANNUAL FLOW (cfs)	PERIOD OF RECORD
Gold Creek at Gold Creek, Montana	12-3246.6	10N11W36AD				26.8	1963 - 1966
Blackfoot River near Potomac, Montana	12-3398	14N16W24CA		200		1,496	1956 - 1965
Blackfoot River near Ovando, Montana	12-3385	15N13W34BD		100	145	855	1940 - 1963
Clark Fork near Garrison, Montana	12-3243	9N9W28CD	71				1961 - 1961
Little Blackfoot River near Garrison, MT	12324590	9N9W16AD	6.3				1972 -
Clark Fork at Drummond, Montana	12331600	11N12W31DBC		58			1972 -
Rock Creek near Clinton, Montana	1234510	11N17W12CA		52			Oct. 1972 -
Clearwater River near mouth	123394050	15N14W32BBB					1974 -
Monture Creek near Ovando, Montana	12338690	15N13W24BAC					1975 -

(1) See Appendix C, System for Geographic Location of Features

TABLE 16. TYPICAL STREAMFLOW DATA FOR UPPER CLARK FORK BASIN (USGS WATER RESOURCES DATA, 1973)

Monthly Mean Discharge (cfs) For Water Year October 1971 to September 1972

STATION	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	TOT. FOR YR. ACRE-FEET	TOTAL FOR AVG. YEAR ACRE-FEET
Silver Bow Cr. at Warm Springs, MT	75.8	96.1	84.5	84.5	89.6	122	107	141	104	51.4	29.8	36.0	61,630	--
Flint Creek at Maxville, MT	96.7	72.6	50.9	50.7	45.8	54.3	61.0	70.5	118	48.1	36.9	55.5	45,890	70,930
Clark Fork at Drummond, MT	594	600	471	505	494	568	509	330	289	118	84.5	262	289,900	--
Rock Creek nr. Clinton, MT	291	229	196	167	167	194	244	837	846	329	162	216	234,300	--
Middle Fork Rock Creek near Philipsburg, MT	50.1	39.9	38.4	36.5	27.5	28.3	39.9	239	257	83.5	38.0	34.5	55,200	88,390
Blackfoot River nr. Bonner, MT	801	676	561	460	473	639	775	2,413	2,145	746	473	446	641,500	1,185,000
Nevada Creek above Reservoir, near Finn, MT	14.7	13.3	10.6	9.39	12.1	30.7	20.4	20.2	11.6	8.25	6.05	8.51	10,020	26,520

The hydrologic and physical characteristics of each major stream in the basin are discussed individually because of varying geological settings and man-related uses which are important in understanding the basin's water quality.

CLARK FORK RIVER

The Clark Fork River originates on the west side of the Continental Divide near Butte, Montana. Headwaters of the river is Silver Bow Creek, which flows about 40 miles before it joins Warm Springs Creek to become the Clark Fork River. The segment of the Clark Fork River included in this plan extends about 120 miles from its headwaters to the mouth of the Blackfoot River near Milltown, Montana. The portion of the river between Butte and Garrison flows through the Deer Lodge Valley. This valley is partially filled by a thick layer of well-sorted silt, sand, gravel and clay. This fill has been eroded into extensive terraces which border both sides of the valley below Warm Springs, Montana. The broad flood plain of the Clark Fork is underlain by a thin deposit of poorly sorted silt, sand, and gravel alluvium. A significant acreage is irrigated in the Deer Lodge Valley. Mining also is active in this region, especially in the Butte area.
The Clark Fork between Drummond and the Milltown passes through a mountainous area. Very little land along the segment is suitable for agriculture; mining activities are not as widespread as in the upper half of the drainage.

LITTLE BLACKFOOT

The Little Blackfoot River begins in an area known as Blackfoot Meadows located on the west slope of the Continental Divide about 15 miles south of Elliston, Montana. The Little Blackfoot flows about 50 miles from its headwaters to the confluence with the Clark Fork River near Garrison, Montana. This drainage covers 398 square miles and is a major drainage of the Clark Fork River. Much of the Little Blackfoot passes through valleys where grazing is the major agricultural use. Most irrigated land in the Little Blackfoot River drainage is located in the river bottoms where the terrain is more suited for this type of land use. Mining activity is centered around two areas of the drainage--the headwaters and Garrison, Montana. Mines in the headwaters produced mainly lead, silver and gold; mines in the Garrison area are the oldest and most important producer of phosphate rock in Montana.

ROCK CREEK

Rock Creek is 56 miles long and flows generally north from its headwaters in the Sapphire Mountains and the Anaconda Range. These rugged mountains are basically composed of Precambrian and Paleozoic sedimentary rocks. The creek then flows through a relatively narrow valley until it merges with the Clark Fork

River about 20 miles southeast of Missoula, Montana. The total Rock Creek drainage includes 900 square miles of mostly forested mountain terrain.

The bed of Rock Creek is characterized by rubble substrate and small, scattered areas of spawning gravel (Haugen, 1971). Rock Creek provides an environment for spring and fall spawning salmonoid species; and is an excellent trout fishing stream. Rock Creek drainage is not used extensively for irrigation, except for the East Fork of Rock Creek where 10,723 acres were irrigated in 1959. (Water Resources Survey, Granite Co., 1959).

FLINT CREEK

Flint Creek is approximately 36 miles long and the drainage includes 490 square miles of forested mountains and relatively broad valley areas. It originates at the southern end of the Flint Creek mountain range. This rugged range is composed of precambrian and Paleozoic sedimentary rock. These headwaters create Georgetown Lake behind the Flint Creek Dam. Water is also diverted into the drainage after leaving Georgetown Lake. Flint Creek enters the broad alluvial Philipsburg Valley and passes through a relatively narrow canyon and mountainous area. It finally enters and crosses a broad gently sloping valley and merges with the Clark Fork River near Drummond, Montana.

As Flint Creek and its tributaries flow through the valley areas mentioned above, significant amounts of water are used for irrigation. Mining activity in the Flint Creek drainage has been prevalent for the past 100 years.

BLACKFOOT RIVER

The Blackfoot River originates near the western summit of the Continental Divide between Roger's Pass and Flesher Pass. The river flows from its source over 120 miles in a westerly direction to Milltown, Montana, which is a small logging community about seven miles east of Missoula. The Blackfoot River follows a narrow valley through mostly forested areas where logging and some agriculture is the major industry. Mining in the upper Blackfoot Valley began in the late 1800's when many millions of dollars of high grade placer gold was taken from the gravel areas of Lincoln Gulch. In the early 1900's, large amounts of lead and other metals were found. As a result, a smelter was constructed on Mike Horse Creek in 1919. Mining continued in the area until after World War II (Spence, 1975). There are presently no impoundments on the Blackfoot River from the source to the mouth. The irrigation reservoir located on Nevada Creek is the only reservoir in the entire drainage. Principal tributaries of the Blackfoot River in downstream order are Alice Creek, Landers Fork, Nevada Creek, North Fork, Monture Creek, and the Clearwater River drainage. The total drainage area is about 2300 square miles. Many tributaries

which enter from the north originate in the remote mountainous region near or in the Lincoln Scape Goat Wilderness Area. They include the Landers Fork and North Fork and Monture Creek. The tributaries which enter from the south show more of man's influence on water quality where mining, lumbering, and agricultural practices influence water quality.

CLEARWATER RIVER

The Clearwater River drainage is bordered by the Mission Range on the west and the Swan Range on the east and it originates at Clearwater Lake, which is a spring-fed 100-acre lake. The river then flows in a general southerly direction through a series of seven lakes before reaching the Blackfoot River approximately 35 miles from its source. These lakes range in size from about 25 acres (Blanchard Lake) to 1,000 acres (Seeley Lake). Approximately 50 percent of the Clearwater River and portions of some tributaries drain stagnant, marshy lands. A good portion of the remainer of the soils are glacial drift deposits which range from clay to boulder-sized materials. Most of the region is unsuitable for farming; logging is the major industry.

BIOLOGICAL CONDITIONS

One of the more common methods used to evaluate water quality is to sample the benthic organisms. This is normally done by collecting all of the macroinvertebrates in a known area of stream bottom. The number of individuals of each kill are counted. This information is used to determine a diversity index. There are many methods of determining diversity indeces. The diversity index is one of the most common and is used in this report. Although there are other methods for evaluatory biological data, the diversity is simple and probably illustrates stream conditions adequately in this situation.

$$\text{Diversity Index} = \frac{S-1}{\log N}$$

Where S = number of kinds (family)
N = number of individuals

The following is the Water Quality Bureau's interpretation of the diversity index.

Diversity Index	Water Quality
less than 2.5	poor
2.5 - 3	fair
more than 3	good

This interpretation is substantiated by fish abundance and chemical water quality in the basin.

Unpolluted waters will support many kinds of bottom fauna but because of predation and competition for space and food, there will be small numbers of each kind. This diversity is good because

an environmental change will probably only affect a small portion of the community at any one time. The other kinds present will fill the role of those eliminated by the environmental change. Thus, the food cycle and system will remain stable.

The number of kinds of organisms are reduced by water quality degradation. The sensitive kinds are eliminated, and only those that can survive the adverse conditions remain. The tolerant kinds increase in number because of the lack of competition and predation. A simplified system lacking in stability results. In a simplified community consisting of a few kinds of animals, a natural environmental change may adversely affect one kind, and as a result eliminate much of the bottom fauna population.

Organic pollution lowers the dissolved oxygen of the stream, and in many cases, deposits a sludge bed on the stream bottom. Thus, the stream becomes suitable only for those organisms that can obtain oxygen from the atmosphere or can exist on low amounts of dissolved oxygen. These organisms also may have to exist on a sludge bed substrate. The so-called clean water animals, such as mayflies (Ephemeroptera) caddisfly (Trichoptera), and stoneflies (Plecoptera) generally require a relatively high dissolved oxygen content and a clean, firm stream bottom. When a stream section becomes organically polluted, these clean water types are replaced by such things as worms (Oligochaeta), snails (Gastropoda) and some types of trueflies (Diptera). It must be pointed out, however, that tolerant organisms are found in both clean and polluted situations and that their presence does not mean a body of water is polluted. However, a population of only tolerant organisms is a good indicator of pollution. Inorganic pollutants, such as siltation, alter the bottom strata and often scour the rocks. The end result is usually a drastic reduction in the population of stream animals.

After the removal of the pollution, the rate of recovery of a stream varies with each situation. Generally those streams that have numerous clean tributaries show the most rapid recovery because organisms living in the tributaries can most easily repopulate the previously polluted main stem.

BIOLOGY

The Upper Clark Fork River basin is primarily a cold water habitat. Salmonoids are distributed throughout the basin with cutthroat and brook trout present in many lakes and streams. Mountain whitefish, rainbow trout and brown trout are abundant in the larger tributary streams and in the Clark Fork River. Rainbow trout are also abundant in several lakes and reservoirs. Dolly varden are fairly abundant in Rock Creek and are scattered throughout the Blackfoot and the Clark Fork Rivers. Arctic grayling, golden trout and kokanee salmon are present in a few lakes. Other species of cold water fish found throughout the basin include large scale sucker, longnose sucker, peamouth chub, redside shiner, northern

squawfish, longnose dace and slimy sculpin. A few yellow perch are present in the Clark Fork River above the Milltown dam and in some of the clearwater lakes. A few warm water species are found in restricted habitats. Largemouth bass, northern black bullhead and pumpkinseed are found in a few sloughs and ponds. Pumpkinseed are abundant in some of the lakes in the Clearwater drainage. Two tropical species, the variable platyfish and mosquitofish, are found in a warm water pond near Drummond (Brown, 1971).

Several aquatic associated mammals and birds inhabit the basin seasonally or year around. The more important of these include beaver, muskrat, mink, canada geese, and mallard ducks. A variety of shorebirds seasonally frequent the basin. Osprey and bald eagles are occasionally observed.

Various pollutants have adversely affected water quality and aquatic life in several areas within the basin. Mine-mill activities have long rendered Silver Bow Creek a biological desert downstream from Butte. Prior to 1954, mine-mill wastes from the Butte-Anaconda area severely polluted the Clark Fork River downstream past the City of Missoula (Spindler, 1959). Construction of a series of settling ponds near Warm Springs for treatment of mine-mill wastes has resulted in a steady improvement in water quality in the river (EPA, 1972). Improvement in biological conditions in the upper portion of the river, however, have been hampered by occasional spills, inadequate treatment and seepage from the ponds. In the past few years, improved water pollution control facilities have been constructed at the mill site. Increase vigilance and maintenance on the settling ponds have continued to improve water quality to where a fair number of brown trout and mountain whitefish now inhabit the river up to the settling ponds (Marcoux, 1974). Invertebrate studies also reveal an improvement in water quality in the upper river; however, several of the common pollution sensitive forms are still absent from the settling ponds to the confluence of the Little Blackfoot River (Wipperman, 1974).

The Anaconda Mining Company wastewater treatment ponds near Warm Springs may have some effect on the health of waterfowl. Mallard ducks collected near Warm Springs during the winter of 1971 were found to contain high levels of cadmium and zinc in liver tissue (Montana Department of Fish and Game, 1971).

Acid mine drainage from the Heddleston Mining District near Lincoln restricts fish and aquatic invertebrate life in Beartrap Creek and depresses aquatic life in a few miles of the Blackfoot River (Spence, 1974). Aquatic invertebrates and fish life are still somewhat depressed by tailings deposits in Flint Creek (from historic mine-mill activities) downstream from Philipsburg (Montana Department of Fish and Game, 1973).

Sediment pollution influences water quality throughout the river.

basin. Activities that cause seditmentation include logging practices, irrigation return flows, overgrazing, stream channelization, road construction, mining, subdivision and urban development. The effects of sediment are often subtle, and damage to aquatic life is sometimes difficult to determine. However, effects of sediment on aquatic life are evident in Union Creek, Elk Creek, and Nevada Creek in the Blackfoot River drainage. Cornish and Basin Gulches in the Rock Creek drainage carry heavy sediment loads during runoff due to past mining activity (Montana Department of Fish and Game, 1971). Extensive logging in the Clearwater River drainage has caused accelerated sedimentation to Rainy Lake and other lakes in the Clearwater chain of lakes (Streebin, 1973). Logging throughout the drainage has contributed to accelerated sedimentation in several streams.

Nutrient enrichment from municipal sewage effluent and industrial waste treatment affects water quality in the Clark Fork River. In 1973, heavy algal growth contributed to diurnal dissolved oxygen sags below levels believed conducive for a healthy aquatic environment (Braico, 1973).

Moose Lake in the Rock Creek drainage Georgetown Lake and Placid Lake have potential eutrophication problems from shoreline development and use (See Section VIII for details).

BASIN IRRIGATION SYSTEMS

According to water resources survey for Powell County dated 1959, Nevada Creek and its tributaries irrigated 11,605 acres (Table 17). The Nevada Creek Project is a part of this drainage and consists of a dam, reservoir, and a canal system for water distribution. The reservoir is located on Nevada Creek about 10 miles southeast of Helmville. During the 1958 growing season, this project irrigated 2,010 acres with an additional 461 acres potentially irrigable (Water Resources Survey, Powell County, 1959).

The East Fork of Rock Creek and its tributaries irrigated 10,723 acres. This includes 4,745 acres irrigated by the Flint Creek Water User's Association. This system utilizes a storage reservoir on the East Fork of Rock Creek about 20 miles south of Philipsburg. The drainage above the reservoir site consists of 32 square miles of high, timbered slopes of the Continental Divide (Water Resources Survey, Granite County, 1959).

The Allendale Irrigation Company irrigates land in the Lower Flint Creek Valley. This system draws its water from Flint Creek and from the Flint Creek Water User's Association. During the 1958 irrigation season, 1,315 acres were irrigated (Water Resources Survey, Granite County, 1959). The Clark Fork River, Lost Creek and Dry Modesty Creek provide water for the West Side Ditch Company. This canal system irrigated 1,125 acres in 1958.

The irrigation projects described are the major systems in the Upper Clark Fork basin. Numerous smaller projects exist but are not described in this report.

(1)TABLE 17. IRRIGATION IN THE UPPER CLARK FORK RIVER BASIN

*Drainage Used for Irrigation	Present Irrigated Acres	Irrigable Acres With Present Facilities	Maximum Irrigable Acres
Clark Fork River	6,651	828	7,479
Race Track Creek	6,635	332	6,967
Dempsey Creek	3,941	134	4,075
Tin Cup Joe Creek	1,960	830	2,790
Peterson Creek	1,308	0	1,308
Cottonwood Creek	3,860	0	3,860
Willow Creek	944	118	1,062
Mill Creek	1,741	0	1,741
Warm Springs Creek	1,960	72	2,032
Little Blackfoot River & tributaries	10,877	150	11,027
Flint Creek & tributaries	17,273	299	17,572
Rock Creek	2,251	219	2,470
E. Fork Rock Creek & tributaries	10,723	761	11,484
W. Fork Rock Creek & tributaries	1,699	38	1,737
Upper Willow Creek & tributaries	1,017	0	1,017
Total, Rock Creek & tributaries listed above	15,690	1,018	16,708
Blackfoot River	3,028	818	3,846
Nevada Creek & tributaries	11,605	863	12,469
Blackfoot River & tributaries including Nevada Creek	29,560	3,233	32,793

*These drainages represent only the major sources for irrigation in the Upper Clark Fork River Basin.

(1) Data compiled from Water Resources Survey, 1959, Granite, Powell, Deer Lodge Counties

VIII. WATER QUALITY

Water quality data were collected by the Water Quality Bureau at 36 stations in the basin (Table 18). Only the major streams were sampled. As a result, it is unlikely that every water quality problem in the basin was examined. The data collected were probably inadequate to completely define yearly variations in quality of each source sampled. These deficiencies were offset in part by using data from USGS and Fish and Game Department sampling stations (Table 18) and results of previous investigations.

TABLE 13. UPPER CLARK FORK WATER QUALITY STATIONS

STATION NAME (AGENCY & NO.)	LOCATION(1)	PERIOD OF RECORD	SAMPLING INTERVALS	WATER QUALITY PARAMETERS
Flint Creek near Drummond, MT (USGS 12331500)	10N12W18ABA	1972 - 1973 (discontinued)	monthly	Dissolved: As, Cd, Cr, Cu, Pb, Hg, Zn, SO_4, Cl, F, Solids, SiO_2, Fe, Mn, Ca, Mg, Na, K, NO_2-N, NO_3-N, P, PO_4-P. Total P, HCO_3, BOD, CO_3, Hardness (Ca, Mg), Non-carbonate Hardness, Sodium Adsorption Ratio, Flow, Temperature, Specific Conductance, DO, pH, Alkalinity, Immediate Coliform
Flint Creek near Philipsburg, MT (USGS 12328500)	7N14W2AA	Oct. 1972 - April, 1973 (discontinued)	monthly	Dissolved: As, Cd, Cr, Co, Cu, Pb, Hg, Zn, NH_3-N, NO_3-N, NO_2-N, P, PO_4-P, SO_4, Cl, F, Solids, SiO_2, Fe, Mn, Ca, Mg, Na, K. Total P, BOD, HCO_3, CO_3, Hardness (Ca, Mg), Non-carbonate Hardness, Sodium Adsorption Ratio, Flow, Temperature, Specific Conductance, DO, pH, Alkalinity, Immediate Coliform
Blackfoot River near Lincoln, MT (USGS 12334600)	15N6W19AD	1968 - 1970 (discontinued)	3 times monthly	Dissolved: Mn, Fe, Mg, F, B, Solids, SiO_2, Fe, Na, K, HCO_3, CO_3, SO_4, Cl, NO_3-N, Hardness (Ca, Mg), Non-carbonate Hardness, Sodium Adsorption Ratio, Specific Conductance, pH, Temperature, Alkalinity, DO, Methylene blue active substance
Blackfoot River below Alice Creek near Lincoln, MT (USGS 12334650)	14N7W5CDD	1970 - 1973	3 times monthly	Dissolved: SO_4, Cl, F, (NO_3+NO_2)-N, PO_4-P, Solids, SiO_2, Cu, Pb, Mo, Hg, Ni, Se, Ag, Co, Fe, Mn, Ca, Mg, Na, K, NH_3-N, NO_2-N, NO_3-N, Cr, Cd, B, Be, Ba, As, Al, Zn, V, Sr, Ag, P. Total P, HCO_3, CO_3, Hardness (Ca, Mg), Non-carbonate Hardness, Sodium Adsorption Ratio, Flow, Temperature, Specific Conductance, pH, Alkalinity, Suspended Sediment. Discontinued for all parameters (Sept. 1973) except temperature.
Blackfoot River below 7-Up Pete Ck, near Lincoln, MT (USGS 12334700)	14N8W23BBC	Oct. 1972 - Sept. 1973 (discontinued)	monthly	Temperature, BOD, Immediate Coliform, Fecal Coliform

TABLE 18 (CONTINUED)

STATION NAME (AGENCY & NO.)	LOCATION (1)	PERIOD OF RECORD	SAMPLING INTERVALS	WATER QUALITY PARAMETERS
Blackfoot River at Dalton Mountain Road Bridge, near Lincoln, MT	14N9W28ABA	Oct. 1972 - Sept. 1973 (discontinued)	monthly	Temperature, BOD, Immediate Coliform, Fecal Coliform
Clark Fork at Deer Lodge, MT (USGS 12324200)	8N9W33CC	1969 - 1971 (discontinued)	monthly	Dissolved: Ca, F, Solids, Al, As, Ba, Be, B, Cd, Cr, Co, Cu, Fe, P, PO_4-P, Pb, Mg, Mn, Hg, Mo, Ni, Se, Ag, Sr, V, Zn. Total: Cu, Fe, Pb, Mn, Hg, Sr, Zn, Pb, SO_4, Cl, NO_3-N, NO_2-N, (NO_3+NO_2)-N, NH_3-N, Organic -N, BOD, TOC, Flow Hardness (Ca, Mg), Turbidity, Temperature, Specific Conductance, DO, pH, Alkalinity, Immediate Coliform, Fecal Coliform
Clark Fork at Garrison, MT (USGS 12324600	9N10W23	1969 - 1971 (discontinued)	monthly	Dissolved: Ca, F, Solids, Al, As, Ba, Be, B, Cd, Cr, Co, Cu, Fe, P, PO4-P, Pb, Mg, Mn, Hg, Mo, Ni, Se, Ag, Sr, V, Zn. Total: Cu, Fe, Pb, Mn, Hg, Sr, Zn, P, SO_4, Cl, NO_3-N, NO_2-N, (NO_3+NO_2)-N, NH_3-N, Organic -N, BOD, TOC, Flow, Hardness (Ca, Mg), Turbidity, Temperature, Specific Conductance, DO, pH, Alkalinity, Immediate Coliform, Fecal Coliform
Clark Fork at Drummond, MT (USGS 12331600)	11N12W31DBD	1971 - 1973 (discontinued)	monthly	Dissolved: Ca, Na, K, SO_4, Cl, F, Solids, NO_3-N, (NO_3+NO_2)-N, NH_3-N, P, PO_4-P, As, Cd, Dr, Cu, Fe, Pb, Mg, Hg, Se, Zn. Total: As, Cd, Cr, Cu, Fe, Pb, Mg, Hg, Zn, N, Kjeldahl-N, P, Flow, Hardness (Ca, Mg), Organic - N, BOD, TOC, DO, Turbidity, Color, Temperature, pH, Alkalinity, Immediate Coliform, Fecal Coliform

TABLE 18 (CONTINUED)

STATION NAME (AGENCY & NO.)	LOCATION (1)	PERIOD OF RECORD	SAMPLING INTERVALS	WATER QUALITY PARAMETERS
Clark Fork near Galen, MT (USGS 12323800)	5N9W7AAA	1971 - 1973 (discontinued)	monthly	Dissolved: As, Cd, Cr, Cu, Fe, Pb, Mg, Hg, Se, Zn, Ca, Na, K, SO_4, Cl, F, Solids, NO_3-N, (NO_3+NO_2)-N, NH_3-N, P, PO_4-P. Total: As, Cd, Cr, Cu, Fe, Pb, Mg, Hg, Zn, P, N. Hardness (Ca, Mg), Turbidity, Color, Flow Temperature, Specific Conductance, DO, TOC, Alkalinity, Immediate Coliform, Fecal Coliform
Blackfoot River near Potomac, MT (F & G 12-3398)	14N16W24CA	1957 - 1965	monthly	Temperature
Nevada Creek above reservoir, near Finn, MT (F & G 12-3355)	12N9W20	1949 - 1965	monthly	Temperature
Blackfoot River near Ovando, MT (F & G 12-3385)	15N13W34BD	1949 - 1963	monthly	Temperature
German Gulch Creek near Ramsay, MT (F & G 12-3235)	3N19W13BD	1955 - 1965	monthly	Temperature
Racetrack Creek below Granite Creek, near Anaconda, MT (F & G 12-3241)	6N11W13AB	1957 - 1965	monthly	Temperature

TABLE 13 (CONTINUED)

STATION NAME (AGENCY AND NO.)	LOCATION (1)	PERIOD OF RECORD	SAMPLING INTERVALS	WATER QUALITY PARAMETERS
Blackfoot River near Bonner, MT (F & G 12-3400)	13N17W9	1949 - 1965	monthly	Temperature
Boulder Creek at Maxville, MT (F & G 12-3300)	8N13W4C	1949 - 1965	monthly	Temperature
Middle Fork Rock Creek near Philipsburg, MT (F & G 12-3320)	5N15W8D	1949 - 1965	monthly	Temperature
Flint Creek near Southern Cross, MT (F & G 12-3255)	6N14W36BD	1949 - 1965	monthly	Temperature
Flint Creek at Maxville, MT (F & G 12-3295)	8N13W9B	1949 - 1965	monthly	Temperature
Blackfoot R at Flesher Pass Rd Bridge (WQB)	15N7W35B	April-July 1974	monthly	Turbidity
Lander's Fork at Hwy 200 Rd Bridge (WQB)	14N8W12C	"	monthly	Turbidity
Poorman Cr at Stemple Pass Rd Bridge (WQB)	14N9W36DDD	"	monthly	Turbidity
Willow Creek near Lincoln (WQB)	14N9W28A	"	monthly	Turbidity

TABLE 18 (CONTINUED)

STATION NAME (AGENCY & NO.)	LOCATION(1)	PERIOD OF RECORD	SAMPLING INTERVALS	WATER QUALITY PARAMETERS
Spring Creek near Lincoln (WQB)	14N9W23B	April-July 1974	monthly	Turbidity
Keep Cool Creek near Lincoln (WQB)	14N9W22A	"	monthly	Turbidity
Arrastra Creek nr Dalton Mtn (WQB)	14N10W30A	"	monthly	Turbidity
N. Fk Blackfoot River (WQB)	14N11W6A	"	monthly	Turbidity
Douglas Cr nr Helmville (WQB)	13N11W21A	"	monthly	Turbidity
Cottonwood Cr nr Helmville (WQB)	13N11W21D	"	monthly	Turbidity
Elk Cr nr Greenough (WQB)	14N15W36A	"	monthly	Turbidity
Nevada Cr at USGS sta above Nevada Reservoir (WQB)	12N9W20	"	monthly	Turbidity
Nevada Cr at Nevada Reservoir outlet (WQB)	12N10W11DDD	"	monthly	Turbidity
Nevada Creek near Helmville (WQB)	13N11W23AAC	"	monthly	Turbidity

TABLE 13 (CONTINUED)

STATION NAME (AGENCY & NO.)	LOCATION(1)	PERIOD OF RECORD	SAMPLING INTERVALS	WATER QUALITY PARAMETERS
Clearwater River Drainage				
Clearwater R near mouth at Hwy 200 (WQB)	14N14W4B	Apr. - July 1974	monthly	Turbidity
Clearwater River between Rainy Lake and Clearwater Lake at Hwy 209 brdg (WQB)	18N16W1B	"	monthly	Turbidity
Richmond Cr at Hwy 209 Bridge (WQB)	18N16W12D	"	monthly	Turbidity
Clearwater River at Lake Alva outlet (WQB)	18N16W24D	"	monthly	Turbidity
Camp Creek at Hwy 209 (WQB)	18N15W31D	"	monthly	Turbidity
Findell Creek at Hwy 209 (WQB)	17N15W6A	"	monthly	Turbidity
Murphy Creek at Hwy 209 (WQB)	17N15W6A	"	monthly	Turbidity
Benedict Creek at Hwy 209 (WQB)	17N15W8B	"	monthly	Turbidity
Clearwater River at Jocko Divide Rd Brdge (WQB)	17N15W17B	"	monthly	Turbidity

TABLE 18 (CONTINUED)

STATION NAME (AGENCY & NO.)	LOCATION(1)	PERIOD OF RECORD	SAMPLING INTERVALS	WATER QUALITY PARAMETERS
Deer Cr near Seeley Lake (WQB)	17N15W20C	Apr.-July 1974	monthly	Turbidity
Morrell Cr at Hwy 209 (WQB)	16N15W14A	"	monthly	Turbidity
Clearwater River at Placid Lake Road Bridge (WQB)	16N15W25B	"	monthly	Turbidity
Owl Creek near mouth (WQB)	16N15W26A	"	monthly	Turbidity
Flint Creek Drainage				
Flint Creek near Hall (WQB)	10N12W18AB	Apr.-Aug. 1974	monthly	Flow Turbidity, SC, pH, Ca, Mg, Na, K, HCO_3, CO_3, SO_4, Cl, NO_3, PO_4, F. Coliform, Cd, Zn, As, Fe, Cu, Pb, TSS, Mn
Flint Creek at Maxville (WQB)	08N13W09B	April, 1974	single sample	Flow, Turbidity, SC
Flint Creek at Black Pines Road (WQB)	07N14W11	"	single sample	Flow, Turbidity, SC
Flint Creek at USGS sta near Southern Cross (WQB)	06N14W36BD	"	single sample	Flow, Turbidity, SC

TABLE 18 (CONTINUED)

STATION NAME (AGENCY & NO.)	LOCATION(1)	PERIOD OF RECORD	SAMPLING INTERVAL	WATER QUALITY PARAMETERS
Silver Bow Cr at pH shack (WQB) (Dissolved & TR)	05N09W18DAB	April, 1974	monthly	SC,pH, Ca, Mg, Na, K, HCO_3, CO_3, SO_4, Cl, NO_3, PO_4. Dissolved: Cd, Zn, As, Fe, Cu, Pb, Mn, Se. Total recoverable: As, Se, Cu, Zn, Pb, Cd, Fe, Mn.
Clark Fork at Deer Lodge (WQB) (Dissolved & TR)	07N09W09BAB	Apr., 1974 continuous	monthly	SC, pH, Ca, Mg, Na, K, HCO_3, CO_3, SO_4, Cl, NO_3, PO_4, Dissolved: Cd, Zn, As, Fe, Cu, Pb, Mn, Se. Total recoverable: As, Se, Cu, Zn, Pb, Cd, Fe, Mn.
Clark Fork at Phosphate (WQB)	09N10W04CCC	"	monthly	" "
Clark Fork at Drummond (WQB)	11N12W31DBD	Apr.-Aug. 1974	monthly	" "
Little Blackfoot River near Garrison (WQB)	9N9W2AAC 9N10W24AC	"	monthly	" "

TABLE 18 (CONTINUED)

STATION NAME (AGENCY & NO.)	LOCATION(1)	PERIOD OF RECORD	SAMPLING INTERVAL	WATER QUALITY PARAMETERS
Blackfoot River at Hogum Bridge (F&G)	14N7W05DDC	March, 1972 May, 1974	Variable	Turbidity, flow
Hogum Creek at Hogum Rd. Bridge (F&G)		June 9, 1972	Instantaneous	Turbidity
Hardscrabble Creek at Hwy. 200 (F&G)	15N07W33A	April 1972 May 1973	Variable	Turbidity
Alice Creek at Hwy. 200 (F&G)	15N07W27D	March 1972 June 1973	Variable	Turbidity, flow
Willow Creek at confluence with Blackfoot River (F&G)	15N07W34	June 1972 May 1973	Variable	Turbidity
Blackfoot River at Flesher Road (F&G)	15N07W35BCA	March 1972 June 1973	Variable	Turbidity, flow
Blackfoot River at Pop's Place (F&G)	15N06W19ACC	March 15, 1972 May 14, 1973	Instantaneous	Turbidity

TABLE 18 (CONTINUED)

STATION NAME (AGENCY & NO.)	LOCATION(1)	PERIOD OF RECORD	SAMPLING INTERVAL	WATER QUALITY PARAMETERS
Blackfoot River at Dalton Mtn. Bridge (F&G)	14N09W28ABA	March 1972-May 1974	Variable	Turbidity, flow
Beaver Creek at Hwy 200 (F&G)		March 1, 1972	Instantaneous	Turbidity
Spring Creek at Hwy 200 (F&G)	14N09W23B	March 1, 1972	Instantaneous	Turbidity
Poorman Creek at Stemple Road (F&G)	14N09W36DD	February 1972-June 1973	Variable	Turbidity, flow
Blackfoot River below 7-Up Pete Creek (F&G)	14N08W14CDD	February 22, & May 17, 1973	Instantaneous	Turbidity
Landers Fork of Blackfoot (F&G)	14N08W12C	March 1972-May 1974	Variable	Turbidity
Copper Creek (F&G)		May 1972-June 1973	Variable	Turbidity

TABLE 18 (CONTINUED)

STATION NAME (AGENCY & NO.)	LOCATION(1)	PERIOD OF RECORD	SAMPLING INTERVAL	WATER QUALITY PARAMETERS
Union Creek McNamara Landing (F&G)		March 13, 1972	Instantaneous	Turbidity
Clearwater River at Hwy 200 (F&G)	14N14W04B	April 18, 1972	Instantaneous	Turbidity
Cottonwood Creek on B-C Game Range (F&G)		April-June, 1972	Monthly	Turbidity
North Fork Blackfoot River at Hwy 200 (F&G)	14N11W06A	June 3,9,20 of 1972	3 per month	Turbidity
Arrastra Creek at Hwy 200 (F&G)	14N10W30A	May-June, 1972	Monthly	Turbidity
Blackfoot River at Canyon Camp (F&G)	14N10W34B	Feb. 1972-May 1974	Variable	Turbidity, flow
Willow Creek at Dalton Mtn Road		March-June, 1972	Variable	Turbidity

Water quality data were collected during the following investigations:

Botz (1969) investigated chemical conditions of surface water in the Upper Silver Bow Creek Basin at 14 sites from 1966-1969.

The EPA (1972) investigated the physical and metal characteristics of the Upper Clark Fork River and major tributaries at 20 sites during the summer of 1970.

Miller (1974) measured the physical, biological, bacteriological, chemical, and metal conditions of Silver Bow Creek and tributaries at 42 sites during 1972-1973.

Van Meter (1974) measured the metal concentration in fish tissue at 25 sites in the Upper and Lower Clark Fork Basin.

Streebin (1973) measured chemical and bacteriological parameters at 17 stations in the Clearwater River drainage during 1971-1972.

Spence (1975) investigated the chemical, physical, biological, and bacteriological condition at 37 sites of the Upper Blackfoot River drainage from 1968-1974.

Streebin (1972) and Haugen (1974) investigated the chemical and physical conditions of Rock Creek and tributaries at 16 sites during 1970-1971.

Land use is the dominant factor influencing water quality in the basin. Activities such as logging, agriculture, mining, recreation, and construction all effect water in the basin.

Streebin (1972) described the following effects of land use on water quality in his report on the water quality of the Rock Creek watershed.

"Logging (may) adversely (affect) water quality principally in three ways: increased sediment production, higher water temperature, and organic waste production. Logging can also have an effect on peak stream flows. Through proper logging techniques, these can be controlled or at least minimized.

Sediment production is recognized as the most serious hazard to game fish resulting from logging activities. The available data overwhelmingly show that sedimentation reduces the survival of salmonoid embryos. (1) This is caused primarily by the affect that it has on gravel permeability and dissolved oxygen levels in the integravel water. Suspended sediment in the form of turbidity is thought to have an adverse effect on salmonoid reproduction, because spawning becomes so concentrated in available clearer water that nests are destroyed by other nest-building females.

Increases in bottom sediment tends to fill the apertures and spaces around gravel, rubble and other bottom irregularities reducing protective cover for young fish and decreasing bottom productivity for aquatic algae and insects. Studies have shown that aquatic reproduction will have an obvious effect on the production of fish which feed upon these insects.

Roads, skid trails and other soil disturbances are the primary cause of sediment and its associated problems. Current knowledge indicates roads are greater sources of sediment in logging than is the clear-cut or harvesting operation itself. (1) Roads and skid trails tend to concentrate runoff and increase erosion hazard.

Prediction of the effects of logging on peak streamflows in a specific area is complicated by the complex relationship among infiltration capacity, compaction and retention capacity, transpiration, and precipitation, but limited data has shown that peak flows can be expected to increase following logging. Accompanying the increased peak flow, abnormal gravel shifting can be expected to occur. Gravel shifting occurring in a stream at critical stages of fish embryo development can be disastrous to fish production. At the other extreme, excess logging debris can clog portions of stream used for spawning forming check dams that reduce flow velocity, and prevent adequate interchange of intragravel and surface waters thereby reducing the oxygen supply to developing embryos. This can also result in the collection of silt on the stream bottom in these areas causing loss of food producing rubble.

Higher water temperatures results from overhead canopy removal adjacent to stream. Complete removal exposes the water to the full impact of solar radiation. The change in temperature may be most dramatic in small, heavily vegetated streams. Removal of vegetation destroys the cool shade sheltering the streambed. Water temperatures dangerously high for game fish may result. All of this points to the value of always preserving the overhead canopy immediately adjacent to streams in the logged area. Precautions should be taken in the planning of shaded areas adjacent to streams to reduce the danger of trees being felled by wind to which they may become more exposed.

Slash and other debris from logging activities contribute to organic and nutrient pollution of streams when they find their way to water. Increases in total dissolved solids, nitrates, and phosphates are some of the changes that might be expected. It is difficult to predict whether this will be detrimental or helpful to fish production, since algae and other constituents of the food web are increased and much depends upon the present condition of the stream. It is reasonable to conclude though, that any change in a stream which presently has a high fish production would be undesirable if the results of the change cannot be predicted.

Many water quality disturbances caused by logging may be traced back to roads and their construction, type of cutting, and yarding techniques. Much information on these practices is found in the recent FWPCA publication, Industrial Waste Guide on Logging Practices.

Roads are recognized as the primary source of sediment in logged areas. To minimize sediment production, care should be exercised in the design and location of roads to prevent channeling water over long distances and at scour velocities.

The prime concern in road locations is keeping roadbeds away from creeks and out of unstable soil conditions. Meadow areas should be protected by locating roads around, rather than through meadows.

Types of cutting have obvious effects on water quality. Current practice employs two basic types, selective-cutting and clear-cutting with many techniques employed for each. Obviously in all cases the most practical technique which will have least adverse effect on stream water quality should be chosen. Type of cutting practice and log yarding technique are largely controlled by tree species, forest management goals, volume of timber, terrains, and topography. All of these aspects must be considered to choose the harvesting techniques that minimize water quality disturbances. In those cases where the harvesting technique to be used will not insure the maintenance of desired stream water quality, the difficult decision as to the ultimate management goals must be made.

Summer Home Development

The immediate impact of summer home development upon the (surface) water quality and environment can in many ways resemble that which could result from unmanaged logging activities . . . . . Whereas logging activities occur in the upland areas, summer home development activities and its associated road construction and land clearing activities occur in areas immediately adjacent to the (streams). Sites near the immediate area of the creek are naturally the most attractive for home developement, and alterations to the terrestrial environment in this area can have the greatest influence on stream water quality.

The influence road construction has on sediment production and peak flows has already been discussed relative to logging activities. Where vegetation is removed along banks of streams, higher water temperatures can be expected to result as in the case with logging activities. Organic and nutrient pollution of stream water can also result from slash and other debris produced by land clearing activities.

The disposal of sewage from home developments along (the streams) poses additional problems. The natural drainage in most of the areas where summer home development is occurring is toward the creek, and it can be expected that improperly disposed sewage will eventually

find its way into the creek. This would be reflected by increased concentration of nitrogenous compounds, phosphates, total dissolved solids and bacterial counts in the creek water.

In the absence of a sewage collection system, the most feasible method of sewage disposal for summer homes in this area is subsurface disposal systems. The satisfactory operation of this type of system depends upon soil conditions, and proper design and construction. Regular inspections of operating units would be recommended to guarantee continued proper operation. The health department regulations for the counties included in the (drainage areas of this project) require permits for the construction or alteration of subsurface disposal systems. These regulations stipulate that the disposal field shall be no closer than 50 feet to any stream. These regulations should provide some protection to the creek, but it has been shown that nitrogenous compounds can, under certain conditions, travel for considerable distances underground. The release of these compounds to the stream would provide an additional source of nutrients for increased algal production.

. . . .

Agriculture

Agriculture in the form of ranching and associated crop production is a major activity in (some of the drainages studied in this project). Storm water runoff over grazing and hay lands and irrigation return flows represent a source of pollution in (these areas). The water pollution problems associated with animal wastes frequently are a drainage problem. Runoff from confinement areas and from land used for disposal of the wastes occurs during and following rainfall or snow melt.

. . . .

Storm runoff and irrigation return flows can be expected to carry large amounts of nitrogen and phosphorus compounds, dissolved organic solids, chlorides and bacteria into receiving waters. Where cultivation is practiced, sediment may also be a problem.

. . . .

With regards to return of total solids, BOD, COD, phosphates and nitrogen to streams from agricultural lands, it has been shown in studies that little is contributed by meadow lands as compared to agricultural practices where soil is tilled or disturbed from its natural state.

Pollution caused by animal production facilities can be as detrimental to a receiving water body as wastes from any other industry. Production facilities and confinement feeding have been developed with little planning and concern for the nuisance and pollutional characteristics inherent in the facilities. Many of the most obvious cases

of pollution could have been prevented if the facilities were located in areas less susceptible to runoff and to accidental release of wastes directly to receiving streams. The economics of pollution and nuisance control in animal production is an important factor and may mean the difference between success and failure for the facility.

. . . .

Recent developments in animal production techniques have altered the traditional concept of including pollution from animal wastes as "background" or uncontrollable pollution. About one-half of the wastes from the remainder accumulate in pens, feedlots, and loafing areas. Increased automation and efficiency of crop use are expected to increase the latter fraction.

Mining

Briefly, the effects on (water quality) that might be expected from mining activity would include sediment production, increased dissolved solids, and increased concentration of certain heavy metals.

The road construction and disturbance of the natural soil state accompanying mine development would be expected to have much the same effect on sediment and peak flows as similar operations connected with other activities already mentioned.

Recreation

Recreational use of Forest Service lands include fishing, picnicking and camping in specified areas, and boating on larger lakes. The pollution potential of these activities depend largely upon consideration exercised by the users in controlling his litter, and by the collection and disposal facilities provided by the Forest Service.

Sport fishing is expected to pose very little threat to water quality. Indiscriminate disposal of bait containers, cigarette or food wrappers, cans, etc. can be unsightly but should cause no problem with water quality.

Environmental problems associated with picnicking and camping are also more of a solid waste than a water pollution problem. However, food and paper waste are readily biodegradable, and since campgrounds and picnic sites are usually located close to the streams, much of the indiscriminantly disposed waste can be expected to find its way into the stream. Campgrounds operated by the Forest Service are provided with sanitary facilities located a sufficient distance from the stream and are so constructed that human waste should not pose a threat to water quality.

Boating is a more serious threat to water quality than any of the other recreational uses. In addition to solid waste (paper, cans, bottle, food stuffs, etc.) which may be intentionally or accidentally deposited in the water, exhausts from boat motors are released under the surface of the water. These gases contain particles, hydrocarbons, and other unburned constituents of gasoline and oil which are detrimental to water quality. Waves from boat wakes may also attack shore lines, resulting in suspension of soil particles and minerals in the water.

SILVER BOW CREEK

Silver Bow Creek (Figure 4) has had pollution problems since placer mining first commenced in Butte in the 1860's. Start of the Anaconda smelter in 1883 added to the problems (Weisel, 1972). Municipal discharges from the cities of Butte and Anaconda were disposed of into Silver Bow Creek. Over the years, the Anaconda Company has invested several million dollars to treat their mining and smelting waste discharges. The Butte operation presently is developing a zero discharge system with complete recycle of process water. Prior to the fall of 1972, the Butte operations' treatment system consisted of a tailings pond used to settle out solid waste material and lime feeders to adjust pH, thus causing chemical precipitation of most dissolved metals. Approximately 25 mgd (millions gallons per day) of water were discharged to Silver Bow Creek from the operation. Additional treatment occurred in the Warm Springs pond system where lime additions precipitated additional metals. Approximately 25 mgd also were discharged from the Anaconda smelter at Anaconda. The smelter discharge received initial treatment in the Opportunity ponds where evaporation, seepage, and some settling occurred (Figure 5). The discharge was then decanted to the Warm Springs treatment ponds where lime was added to precipitate metals. The flow diagram for the Anaconda Smelter and reduction works is shown in Figure 5. On September 29, 1972, the Butte operation of the Anaconda Company completed installation of a new water pollution control system based on recycle of process water (Higgins 1974). The process water is treated in the tailing ponds, decanted and recycled through the concentrator as shown in Figure 6. Underground mine water is used as makeup water in the system along with some fresh water. Approximately 4½ mgd of fresh water are used for gland seal on pumps, fire control, and sanitary facilities. Between four and six million gallons per day of process water are discharged to Silver Bow Creek along with approximately 0.01 mgd from the Continental East Pit operation. Additional emergency pond capacity has been constructed to facilitate any spills which may occur in the operation. Butte Metro's sewage treatment plant discharges six to ten mgd of treated sewage to Silver Bow Creek. Weekly, they dump sludge into the stream. Sludge dumping will be discontinued as soon as an alternate disposal method has been developed. Storm drains in Butte also add significant amounts of metals to Silver Bow Creek. A survey of storm sewers conducted by the Water Quality Bureau in cooperation with the Anaconda Company during 1974-75 showed storm drains and collection ditches contribute the majority of the iron, copper and zinc entering Silver Bow Creek in Butte (Table 19). A drain ditch from the Colorado tailings contributes a large metals load to Silver Bow Creek. Apparently, groundwater is continually leaching from these old mill tailings.

Septic tank effluent from the town of Rocker is discharged directly to Silver Bow Creek (Comprehensive Areawide Water and Sewer Plan, 1970). Rocker is high on the construction grant priority list for

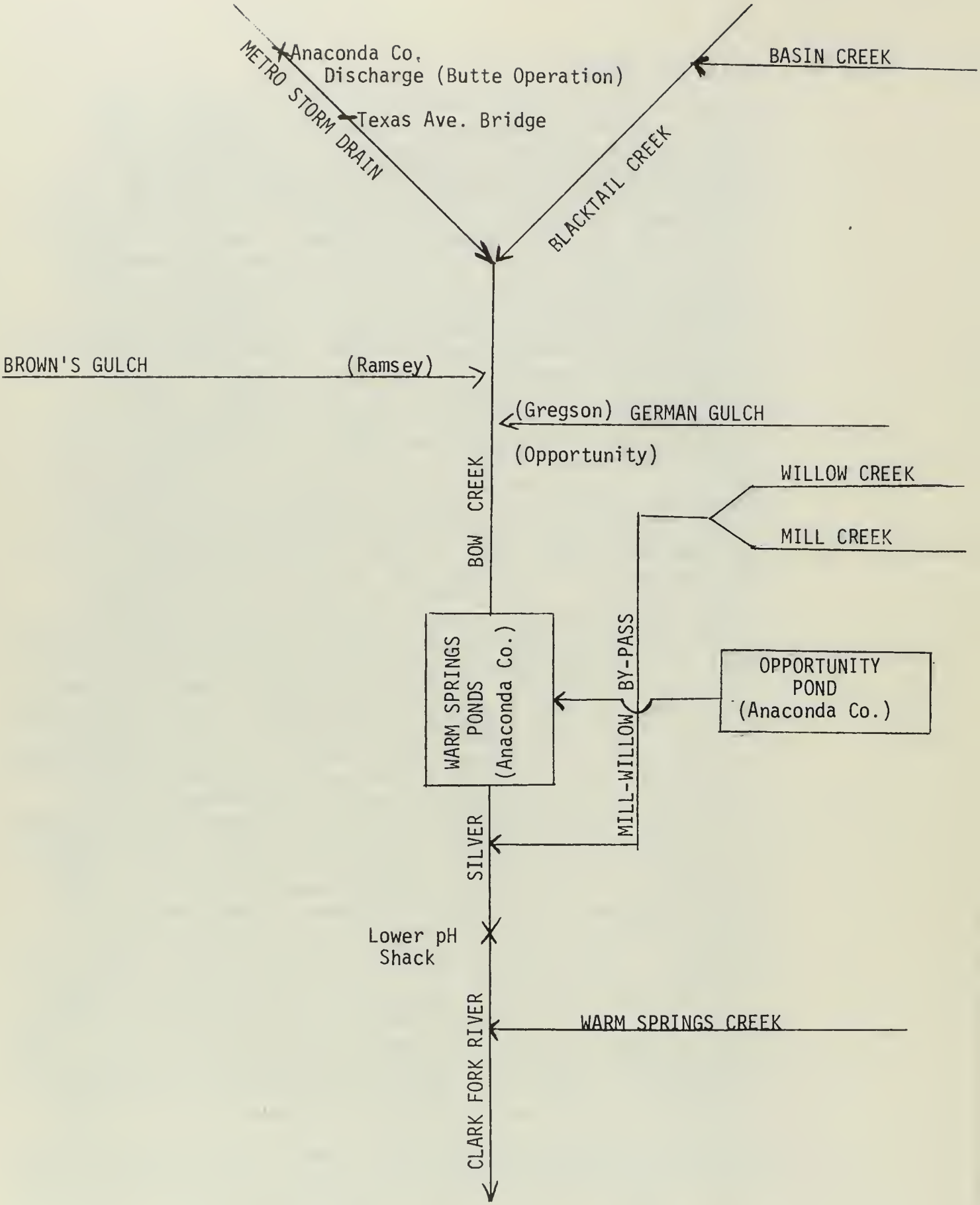


FIGURE 4. SCHEMATIC OF SILVER BOW CREEK DRAINAGE

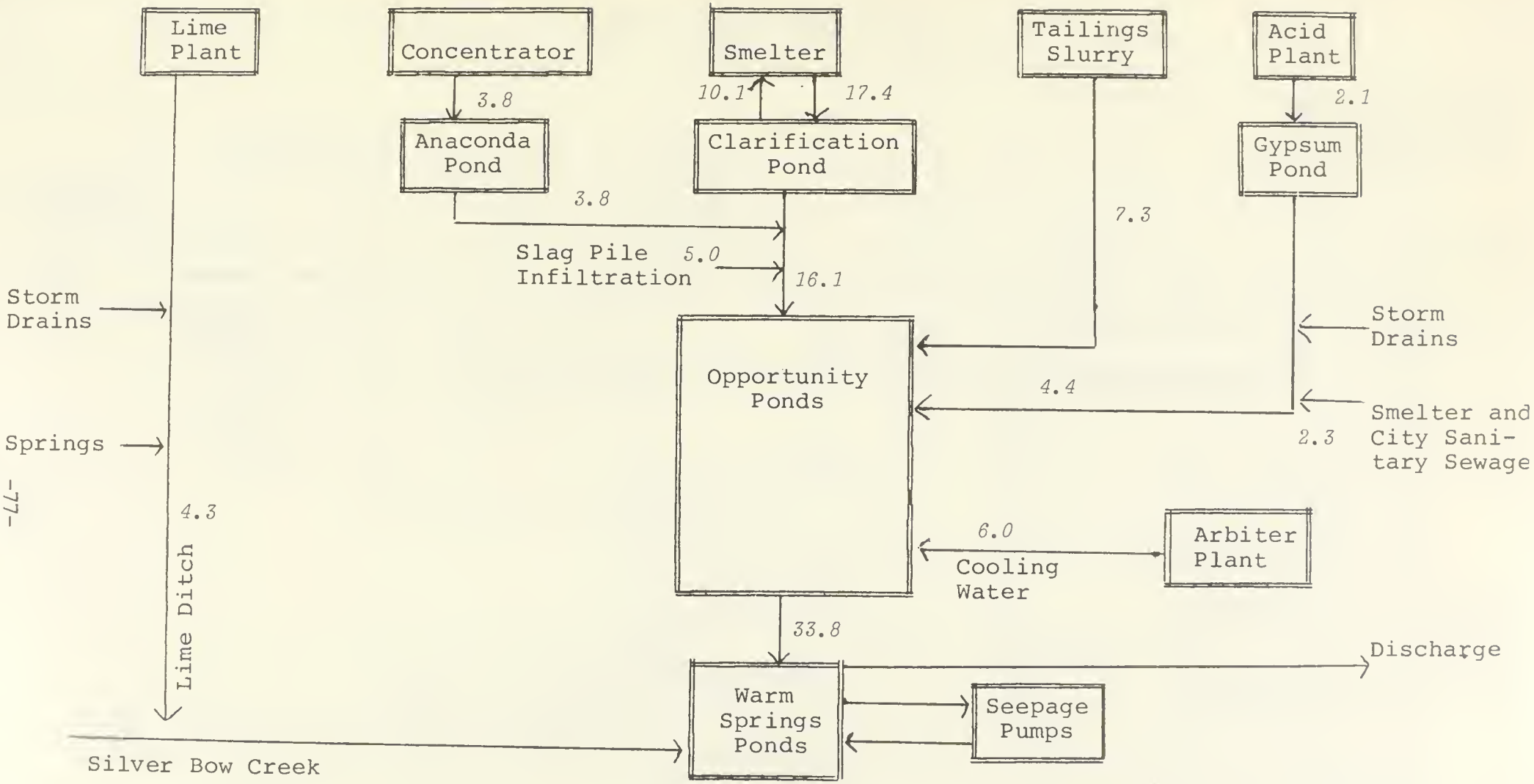


FIGURE 5. ANACONDA REDUCTION WORKS TREATMENT SYSTEM
(flows expressed in million gallons per day)

EFFECTIVE JUNE 1975 *(Anaconda Company Information)*

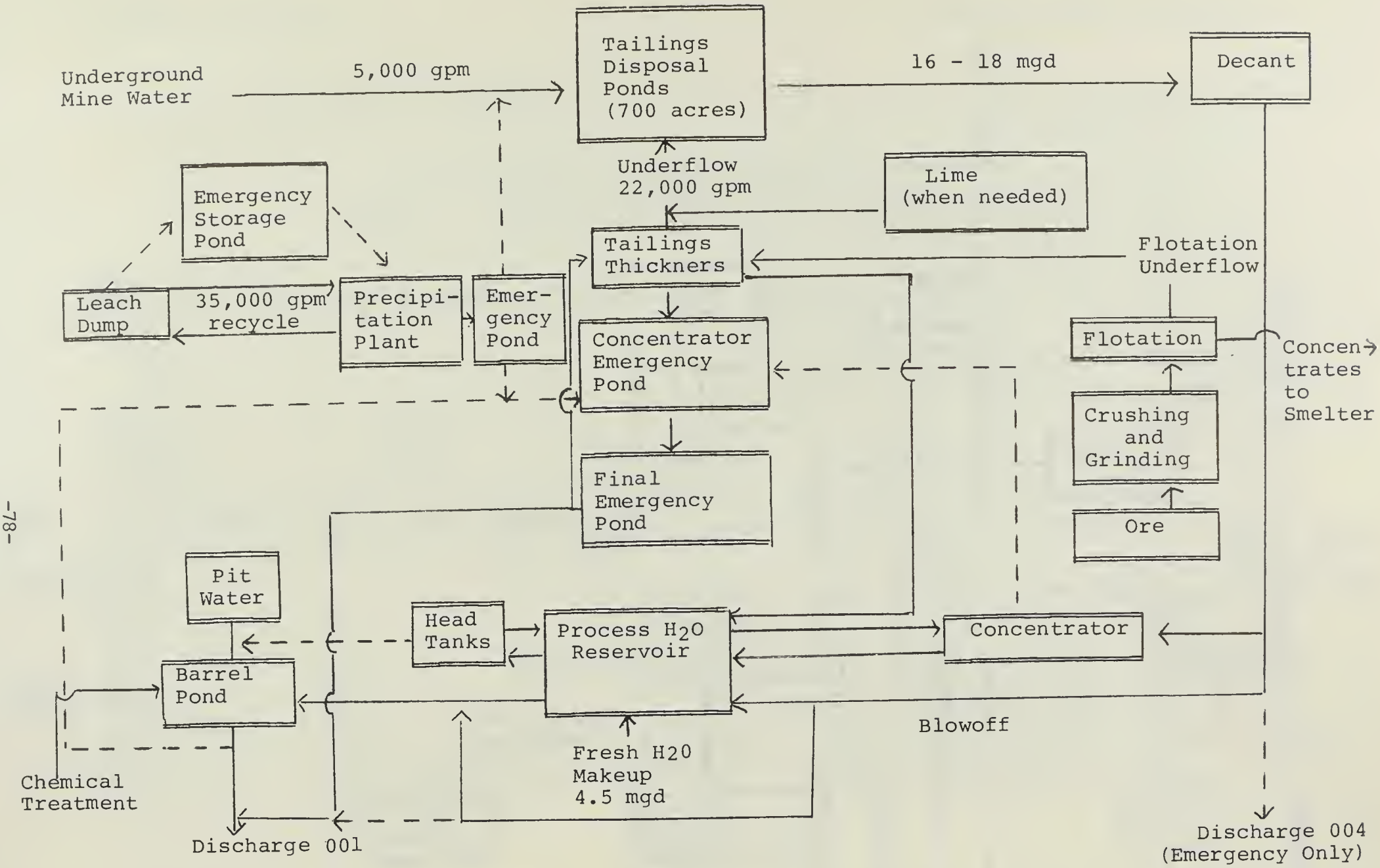


FIGURE 6. BUTTE OPERATION WASTE TREATMENT SYSTEM
(Anaconda Company Information)

TABLE 19. BUTTE AREA SOURCE CONTRIBUTORS TO METAL LOAD IN SILVER BOW CREEK - 1974

Source	Fe	Cu	Zn	Mn	Cd	Pb	As
	(pounds per year total metals)						
ANACONDA COMPANY							
[1]Butte Operations	8700	4900	7100	NM[5]	3700	1000	900
[2]Continental East	100	100	100	NM	INS[6]	INS	INS
TOTAL	8800	5000	7200	NM	3700	1000	900
[3]Butte METRO STP	10,300	1300	4900	2800	INS	900	NM
[4]Storm Sewers	54,600	7500	31,600	9200	100	700	600
TOTAL	73,700	13,800	43,700	12,000	3800	2600	1500

1. Anaconda Company data.

2. Assuming full year operation, although discharge began in mid-year 1974 - Anaconda Company data.

3. Water Quality Bureau data collected March 12, 1975.

4. Total recoverable metals.

5. NM = not measured

6. INS = insignificant

a central facility (Appendix D) and will receive step 1 funding in Fiscal Year 1976. Domestic sewage from Anaconda is treated in the Anaconda Company Opportunity and Warm Springs ponds before being discharged to Silver Bow Creek. Domestic sewage from Opportunity is thought to be reaching Willow Creek. A combined treatment system for Anaconda and Opportunity is currently being evaluated.

The present condition of Silver Bow Creek has been described by Weisel (1972) as a "biological desert". Recent biological studies by the Environmental Protection Agency (Fox, 1972) and Montana College of Mineral Science and Technology (Gless, 1973) has shown the stream to be almost void of invertebrates from Butte to the Warm Springs ponds. This is primarily due to metal loads and the lack of a substrate suitable for aquatic organisms. Silver Bow Creek tributaries also were investigated by Fox and Gless. Blacktail Creek and Basin Creek form the headwaters of Silver Bow Creek. Benthic samples of Blacktail Creek collected by Gless showed the diversity index to gradually decrease downstream but to remain good overall. The decrease is thought to be due to a decreased stream gradient in the metropolitan area of Butte (Gless, 1973). Channelization in the lower reaches of the stream also may influence diversity. The chemical condition of the stream is good. Total coliform counts were well within water quality standards for a B-D_1 stream. Basin Creek showed a low diversity index of less than two near the confluence with Blacktail Creek. Basin Creek has been found to have extremely high total and fecal coliform counts near the confluence with Blacktail Creek (Gless, 1973).

These coliform counts are above accpetable levels for a B-D_1 stream.

The stream in Horse Canyon, although presently not classified by current Montana water quality standards, is a small stream originating in the Columbia Gardens area and reaching the Metro storm drain (Silver Bow channel) near the Butte concentrator. Fecal and total coliform counts in the stream below Columbia Gardens were above acceptable B-D_1 levels when tested in 1972. Anaconda Company began discharging mining wastewater into the creek during the late summer of 1974. (The influence of the discharge on stream quality has not been evaluated.) Browns Gulch and German Gulch, both tributaries of Silver Bow Creek, contain diverse populations of invertebrates with many pollution sensitive organisms. German Gulch exemplifies a good trout stream with an ideal substrate and a high diversity index of greater than four (Fox, 1973). The lower reach of Browns Gulch is badly dewatered during the irrigation season.

The upper portions Mill, Willow, and Warm Springs Creeks are high quality streams with good diversity indices. The water quality deteriorates near the Anaconda Company Opportunity and Warm Springs treatment ponds. Miller (1974) found the specific conductivity to increase in Mill-Willow bypass and Warm Springs Creek, indicating possible seepage from the Anaconda treatment ponds. Species diversity indicated an unhealthy situation with a monoculture of diptra in the

Mill-Willow bypass near Warm Springs and the same situation in Warm Springs Creek downstream from Highway 10 (Gless, 1974). Cause of this degredation may be related to water chemistry or to temperature effects and loss of habitat due to dewatering.

An examination of the streambed by Gless (1973) at the lower pH shack below ponds showed no invertebrates. The Water Quality Bureau collected a sample in the same vicinity in May, 1974 and found one pteronarcella (stonefly nymph) and two hydropsychidae (caddis fly larvae), (both pollution sensitive organisms), and a dozen less sensitive midge larvae. This indicated a recovery trend in the stream.

There is a downstream increase in total metals and sulfates in Silver Bow Creek (Table 20). This apparently is due to leaching of old sediments deposited along the stream. Typical flow data and concentration data were not available for the same time period. Flow data from 1972 - 1973 were used with concentration data from 1974.

The validity of this method is substantiated by the following flow data comparison:

(1) Montana Tech reported an average 151 cfs at the lower pH shack during 1972 - 1973 compared with 157 cfs reported by the WQB during 1974.

(2) Anaconda Company measured 85 cfs at Opportunity during seven months in 1974. The flow during the remaining five months would easily bring the flow to 130 cfs as reported by Montana Tech during 1972 - 1973.

Sediment leaching was not found by Deibold (1974) during laboratory studies; (he found metals in solution decrease when contacted with Silver Bow Creek sediments), however, Diebold was measuring dissolved metals, not total metals.

Table 21 shows the change in metal load through the Warm Springs pond system and the metal removal efficiencies. The ponds removes 75-90 percent of the iron, copper, zinc, cadmium, and arsenic entering the ponds in Silver Bow Creek and excluding the smelter. Preliminary information indicates that the metal loads observed at the lower pH shack are about twice the load actually discharged from the ponds (Table 20). Groundwater seepage is apparently the reason for the difference in loads. The specific conductivity survey of Mill and Willow bypass by Montana Tech in November, 1972 indicated an underflow through the levies of Warm Springs pond two and three (Miller, 1974). A similar survey on Warm Springs Creek indicated pond seepage from the Opportunity ponds entering the creek commencing two miles west of the state hospital (Miller, 1974). A thorough survey of the dynamics of the pond seepage situation is needed to determine metal load contribution from this source on the Clark Fork River.

A major question is allowing Silver Bow Creek to bypass the Warm Springs ponds untreated. To estimate the impact on the Clark Fork River, metal loads in Silver Bow Creek at Opportunity were used to determine if these loads, when diluted in the Clark Fork River, would violate Montana water quality standards set for the river. Copper, zinc and arsenic concentrations exceeded the standards (Table 22). Contribution from the ponds would likely cause iron and cadmium concentrations to also exceed the standards. Based on this information, it appears unlikely that the ponds can be bypassed. However, this discussion was based on average load and does not mean that part of the year it may be possible to bypass without violation.

TABLE 20. TOTAL METAL AND SULFATE LOADS IN SILVER BOW CREEK, 1974

LOCATION	Fe	Cu	Zn	Cd	Pb	As	SO_4
				(pounds per year)			
Texas Ave. Bridge	22,000	13,200	17,600	400	2,000	2,400	7.08×10^7
Confluence Blacktail Cr.	151,500	39,900	94,800	1,200	3,400	3,000	10.1×10^7
Ramsay	347,000	69,900	163,600	1,300	4,900	3,826	8.05×10^7
Gregson	572,000	113,100	222,100	1,900	9,800	16,300	9.30×10^7
Opportunity	508,000	142,000	301,000	4100	6700	6900	9.5×10^7
Warm Springs pond discharge	55,000	15,100	22,200	1000	3400	1450	2.7×10^7
Lower pH Shack	116,000	27,000	57,000	1800	5700	4800	10.6×10^7

Load calculated using 1974 Anaconda Company concentrations and 1972 - 1973 Montana Tech. flows.

TABLE 21. METAL REMOVAL EFFICIENCY IN WARM SPRINGS PONDS

	Fe	Cu	Zn	Cd	Pb	As
Metal load in Silver Bow Creek at Opportunity, MT (Table 20) lbs/yr.	508,000	142,000	301,000	4100	6700	6900
Metal load in Silver Bow Creek at lower pH shack (Table 20) lbs/yr.	116,000	27,000	57,000	1800	5700	4800
Removal efficiency (%)	89	90	93	76	49	79

TABLE 22*. CALCULATED CONCENTRATION OF METALS IN CLARK FORK RIVER ASSUMING METAL LOADING AT OPPORTUNITY IS DILUTED BY CLARK FORK RIVER.

	Fe	Cu	Zn	Cd	Pb	As
Calculated total metal concentration (mg/l) in the Clark Fork River	1.1	0.3	0.7	0.009	0.015	0.015
Montana water quality standards (mg/l)	1.3	0.09	0.3	0.019	0.10	0.01

*Note - This table was developed by converting metal loads in Silver Bow Creek at Opportunity (Table 20) to concentrations in the Clark Fork River at Warm Springs assuming a flow of 228 cfs and no metal input from Warm Springs Creek.

A metal concentration limit could be established for Silver Bow Creek at Opportunity and when metal levels are below these limits, the ponds could be bypassed. A load limit cannot be established until seepage characteristics of the ponds are understood and described. It will also be necessary to know the contribution of the Anaconda Smelter on the metal load reaching Silver Bow Creek. Additional emergency storage systems must be provided upstream to eliminate accidental spill and/or slugs of poor quality water.

A metal concentration limit could be established with a monitoring station in the Clark Fork River near Warm Springs and developing baseline data on metal loads in the river. These data could be compared to Silver bow Creek data at Opportunity to establish the feasibility of pond bypassing. If it appeared feasible, then an automated sampling and flow diversion program could be established in which a number of key parameters could be monitored both upstream and at Warm Springs.

CLARK FORK RIVER AND TRIBUTARIES

In 1960, the Montana State Board of Health and the Montana State Fish and Game Department conducted a macroinvertebrate study on the Clark Fork River basin. They concluded that the main stem of the river from Warm Springs to the confluence with the Little Blackfoot River (Figure 7) was in poor biological condition (Averett, 1961). Mine-mill wastes from the Anaconda Company were considered to be the cause of the depressed aquatic conditions. Cementing of the bottom with a gypsum and metal hydroxides had reduced the suitable substrate available for aquatic organisms. The section of the river below the Little Blackfoot to Rock Creek contained relatively large numbers of organisms at each station sampled. Also sampled were Warm Springs Creek near Warm Springs, the Little Blackfoot River, Flint Creek and Rock Creek. Each of these was found to be in excellent biological condition.

In 1970, the Environmental Protection Agency (EPA) conducted a similar water quality study on the Upper Clark Fork in which they checked the stream biological quality at 20 sites. They found the Clark Fork River between the mouth of Warm Springs Creek and Deer Lodge to be biologically degraded. Their report stated (EPA, 1972) "There is almost a total lack of benthic biota at Warm Springs, Montana, and the number and diversity of organisms at Dempsey Station and Deer Lodge, Montana are still not indicative of a healthy system. The fish population studies indicate that no significant game fish populations exist in this reach of the river".

Between Warm Springs and Garrison, Montana, they found the average number of kinds to increase over 500 percent. Below Dempsey Station, there was less than half the number found at Dempsey Station. However, most of the number of organisms at Dempsey Station was made up of one or two pollutant tolerant species. As water quality improved going downstream from Dempsey Station, the number of pollutant sensitive kinds of animals increased until at Garrison the number of kinds represented a well-balanced community of benthic organisms. Water quality improved progressively downstream, and at Drummond, Montana river conditions approached the high quality of tributaries. During the 1960 study, the diversity index of aquatic species improved downstream to Garrison (Table 23) whereas during the 1970 and 1974 studies, the diversity index reached its peak at Deer Lodge, thus indicating that the river has improved in quality downstream of Deer Lodge over the time span covered between reports.

On July 27, 1974, the Water Quality Bureau conducted an air surveillance survey of the Clark Fork River drainage. The river appeared to have intermittent bright green algae blooms starting below Deer Lodge and becoming more dense until near Drummond, the entire streambank appeared green. Downstream from Drummond, the green gradually appeared darker in color and the blooms became more

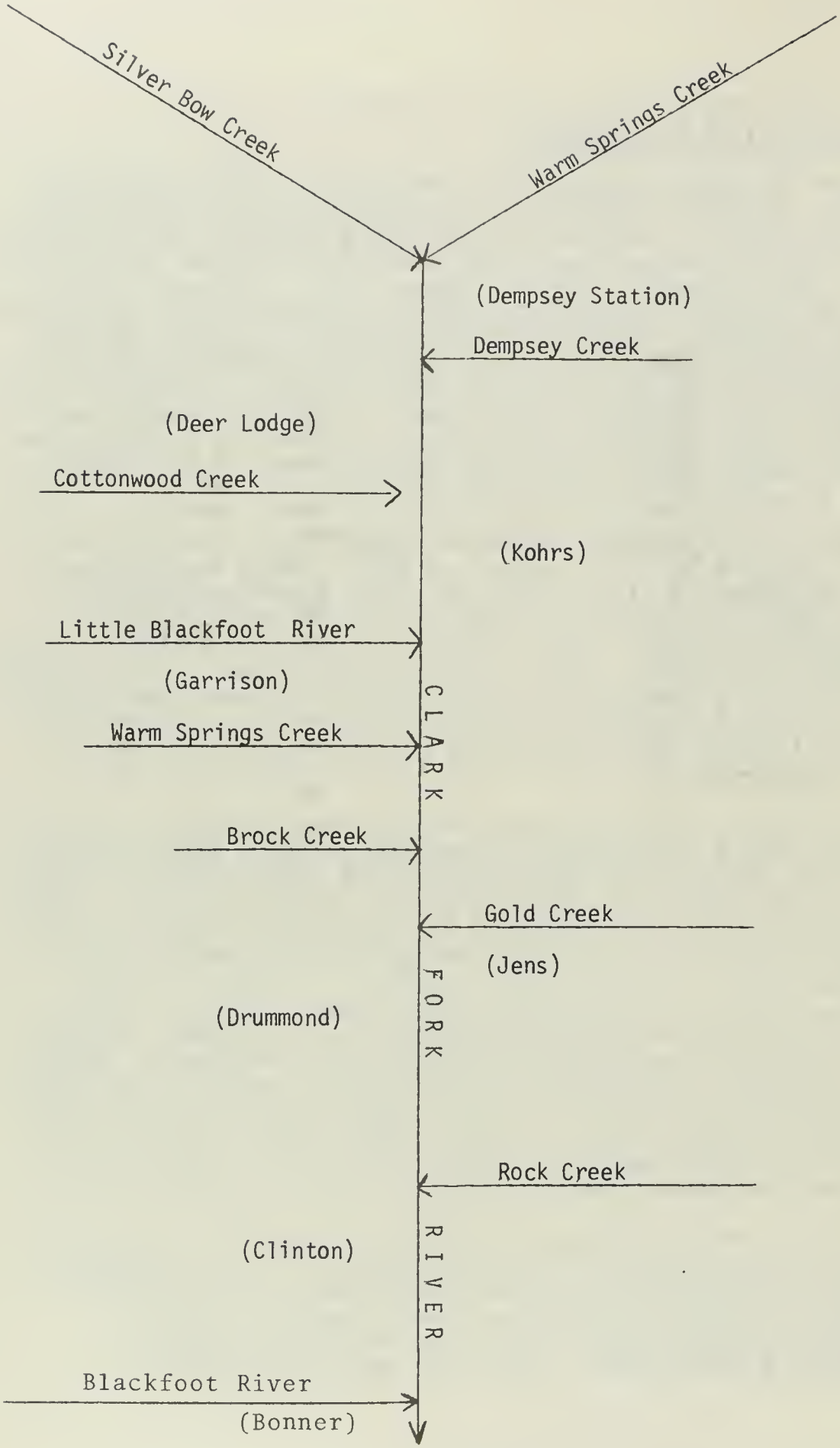


FIGURE 7. SCHEMATIC OF CLARK FORK RIVER DRAINAGE

TABLE 23. DIVERSITY INDEX OF BENTHIC ORGANISMS IN THE CLARK FORK RIVER AND TRIBUTARIES

$$\text{Diversity Index number} = \frac{S-1}{\text{Log } N}$$

Where S = number of taxa
N = number of individuals

Study	Date	Silver Bow Cr. at lower pH Shack	Clark Fork Rvr. at Deer Lodge	Clark Fork Rvr. at Garrison	Little Blackfoot River at Garrison	Flint Creek near Drummond
1960 Montana State Board of Health and Montana Fish and Game	7/12	2.23	3.02	5.83	4.01	3.16
	9/19	2.35	5.10	4.61	4.48	2.24
1970 EPA Study	8/12	1.77	4.16	3.41	5.83	NM
1974 WQB Survey	3/26	2.49	4.61	NM	5.32	NM

intermittent and finally disappeared about ten miles below Drummond. There were scattered blooms below the mouth of Rock Creek and blooms gradually disappeared near Bonner. In August of 1974, Region VIII EPA conducted an intensive survey of the Clark Fork for two weeks. The purpose of their survey was to determine the causes and magnitudes of algae blooms which appear to be getting larger each year. Results of this survey have not been published.

The Water Quality Bureau conducted algal assay tests in 1975 to acquire an understanding of algae growth potential in the Clark Fork River below Warm Springs. Algal assay tests were conducted in the laboratory under controlled light and temperature conditions using a monoculture of Selenastrum to measure the algal growth response. Water samples are placed in glass flasks innoculated with Selenastrum. Nutrient additions are made according the the test objectives (EPA, 1971). Results of algae tests run on water from the lower pH shack--(One in January and one in February, 1975) showed no growth response to additions of nitrate and phosphate indicating either metals or another nutrient may be growth limiting. A second series of tests using added micronutrients showed no additional algal growth increases indicating metals probably are the limiting factor in water at the lower pH shack. The Clark Fork River water above and below Deer Lodge also was tested in January, 1975 to ascertain what influence the Deer Lodge sewage lagoon discharge may have on river algal growth potential. Growth in the water (as interpreted from the laboratory algal assay tests) above Deer Lodge increased seven-fold when combined additions of nitrate and phosphate were added. Growth in the natural water below Deer Lodge was significantly higher than growth in natural water above Deer Lodge. In fact, growth in the natural water below Deer Lodge was almost identical with that in the water above Deer Lodge that had additions of nitrate and phosphate. Additional amounts of nitrate and phosphate added to the natural water below Deer Lodge had little effect on the growth. These tests suggest that the Deer Lodge lagoon effluent is supplying needed nutrients for the heavy algae growths observed below Deer Lodge.

In another test, water was collected from above Deer Lodge in February and tested to ascertain why summer algae blooms were not prevalent from Warm Springs to Deer Lodge. Tests at the upper pH shack in January showed no growth response to nutrient additions, indicating that metals may be inhibiting. Zinc and copper were added to the water above Deer Lodge in concentrations that would make the water comparable in concentrations to that at the lower pH shack. Water with metals added caused a 15-fold decrease in growth. Metal additions also were run on Clark Fork River water collected as Phosphate and the results were similar, thus indicating that zinc and copper levels found at the lower pH shack do inhibit algae growth.

A set of test were run in March, 1975, to ascertain what influence the Phosphoria Formation downstream from Garrison may have on algal

growth in the Clark Fork River. Water was collected at Phosphate and growth was compared with water collected at the town of Gold Creek, which is below Brock and Warm Springs Creeks, the two major tributaries with drainage from the Phosphoria Formation. Results of the tests showed no significant change in growth at Gold Creek indicating no significant change in algal growth potential in the Clark Fork River as a result of drainage from the Phosphoria Formation.

The Clark Fork River rapidly gains groundwater between Dempsey Creek and Deer Lodge, and the nutrient and metal loads also increase (Table 24). The increase in nutrient load between Deer Lodge and Kohrs is the result of the Deer Lodge lagoon effluent. The steady decrease in nitrates below Deer Lodge may be due to the uptake of nitrate by the heavy algae blooms in the river at that time of the year.

TABLE 24. POUNDS PER DAY OF NUTRIENTS AND METALS IN CLARK FORK RIVER AND TRIBUTARIES*

Station	Flow (cfs)	NO_3-N	NH_4-N	PO_4-P	T-N	T-P	Total Cd	Total Cu	Total Fe	Total Pb	Dissolved Zn	Dissolved Cu
Clark Fork R. at Dempsey Cr.	70	70	10	5	230	10	<5	15	90	10	15	5
Clark Fork R. at Deer Lodge	140	170	15	10	430	25	5	30	290	15	15	10
Clark Fork River at Kohrs	150	150	15	40	530	70	5	30	390	40	15	10
L. Blackfoot R. at Garrison	80	5	10	15	100	20	<5	<5	55	ND	<5	<5
Clark Fork R. at Garrison	230	60	25	55	600	85	10	35	480	15	30	15
Clark Fork R. at Warm Springs Cr.	240	25	25	90	610	120	15	40	410	85	15	10
Clark Fork R. at Gold Creek	260	20	40	140	670	170	15	40	450	45	25	15
Clark Fork River at Avons	270	<15	30	65	740	90	10	75	450	25	15	10
Flint Creek at Drummond	90	30	10	35	180	41	<5	5	120	ND	<5	<5
Clark Fork R. at Drummond	400	20	45	115	860	150	30	45	540	50	25	30
Clark Fork R. at Rock Creek	450	<25	25	70	830	100	10	65	460	ND	<15	<15
Rock Creek	420	25	45	20	380	45	<10	15	310	ND	<10	<10
Clark Fork R. at Clinton	870	<45	95	75	1100	130	<25	120	650	ND	<25	<25

*Nutrient measurements used in the load determinations were taken by EPA during a two week survey in August, 1975. Flow measurements were taken by the WQB during the same time period.

The large increase in ortho and total phosphate below Garrison is the result of erosion from the natural Phosphoria Formation. Fish tissue analysis for metals conducted in 1970 found copper, zinc, and cadmium concentrations within the normal range (EPA, 1971). Lead was higher than the tolerants limits set by the U.S. Food and Drug Administration; however, few samples were taken and analytical detection limits in the study make the results uncertain.

Van Meter (1974) tested specimens of game and rough fish for cadmium, lead, silver, and zinc, and found lead and silver to be at acceptable limits at all stations.

Metal and nutrient pollution is not the only problem that has adversely affected the quality of the Clark Fork River. Massive stream alterations during railroad and highway construction occured around Bearmouth where the stream is confined to a narrow valley. Meanderings have been replaced by straight sections and streamside vegetation has been replaced by riprap (Weisel, 1974). Channel straightening reduces the detention time of water and therefore increases the chances of downstream erosion and flooding. Increased stream sedimentation smothers fish eggs and aquatic insect larvae by covering spawning areas and the insect substrate. Channel straightening tends to increase the water temperature by directing water to the center of the channel and away from the shaded areas. Belding (1928) notes even slight increases in temperatures of trout streams generally are undesirable. Further, streams which become too warm only one day per year cease to be trout streams (Needham, 1938). The maximum temperature which any of the trout species for even brief periods of exposure appear to be about 82 degrees Fahrenheit (Embody, 1921 and MiGonigle, 1934). Species selection, food availability, attended life cycle chemistry and water quality changes are all affected by temperature (EPA, September, 1973). Further, not only absolute temperature but also temperature variations affect fish and associated aquatic life (EPA, 1973).

The Water Quality Bureau performed a two-day survey during August of 1973 to measure the diurnal dissolved oxygen and temperature profiles at four stations on the Upper Clark Fork River; one station on the Blackfoot River, and one station on Rock Creek (Braico, 1974). At each of these stations, dissolved oxygen sagged below the limits set by the Montana Water Quality Standards (Appendix D). Results of the survey showed the standards were exceeded during early morning hours due to respiration of aquatic plants. Braico also reported conditions of the Clark Fork River at Rock Creek Bridge to have reached critical temperature and dissolved oxygen levels. The water temperature exceeded the desired maximum of 68 degrees Fahrenheit for a 12-hour period, dissolved oxygen dropped to 5.2 milligrams per liter, and high water temperatures and low DO conditions existed simultaneously for a sustained period of over five hours at the Rock Creek Bridge Station. Conditions

at all other stations appeared satisfactory for salmonoid survival. Temperatures at these stations were high but DO remained above the critical limit.[1]

1. For cold-water fish, the FWPCA, 1968, recommends DO concentrations at or near saturation. Dissolved oxygen levels below 6 milligrams per liter are not recommended if good growth and maintenance of trout plus associated aquatic organisms are to be maintained. Dissolved oxygen levels between five and six milligrams per liter are permissible for short periods under adverse circumstances if normal daily and seasonal fluctuations occur and if water quality is favorable (FWPCA, 1968).

The water quality in the Clark Fork River system has been greatly improved in the last 25 years due to the efforts of the Anaconda Company to control the waste load of heavy metals reaching the Clark Fork River. At one time, these heavy metals were allowed to discharge untreated into the Clark Fork River water system. Below Deer Lodge, the Clark Fork River has gradually recovered to a point where it is a good fishing stream and water above Deer Lodge is showing signs of recovery. There is still an occasional spill of heavy metals into the river from the Anaconda treatment system at Warm Springs; however, they are becoming less frequent as a result of better control methods. Perhaps one day Silver Bow Creek will also support a trout population, but it will probably be quite a number of years before this can occur due to metals present in the stream sediments.

GEORGETOWN LAKE

Georgetown Lake was formed in 1885 as the reservoir of a small dam built across Flint Creek by Montana Water and Electric Company to produce power for mining concerns around Philipsburg. The Anaconda Company constructed a larger masonary dam in 1901 and raised it to its present height in 1919. The present-day impoundment contains approximately 30,500 acre-feet of water with a surface area of about 2800 acres. Georgetown Lake appears highly eutrophic and the problem stems from the fact that the lake is fertile and average lake depth is 11 feet and the maximum depth only 35 feet. Approximately ten percent of the lake is over 25 feet deep. The area was a hay meadow before the dam was built and thus there was a good organic load since the lake's inception. The shallowness of the lake has resulted in excellent fish production over the years. Large cutthroat, four pounds and over were common prior to 1937. A lake drawdown below normal resulted in a severe winter kill in 1937 and as a result, good fishing was not reestablished until the 1940's. During the late 1940's fishing was again spectacular. Rainbow trout and Coho salmon were predominant. Fish up to 12 pounds with the average of four to five pounds were creeled. In the 1950's the sizes of fish became smaller, apparently due to increased fishing pressure and harvest. Present-day stocking programs call for 250,000 four to six-inch rainbow to be planted annually after the ice goes off. The fish grow to catchable size by the late fall. The lake's shallowness has caused an extensive growth of rooted aquatic plants. Wright (1974) has found the lake to be well oxygenated during the summer months. However, during

the winter, the lake is capped with ice. As a result, the oxygen using bacteria which decompose the dead plants quickly use up the lake's fixed supply of oxygen. Once the ice cover is established, Wright found the oxygen concentration to drop rapidly to zero below the four meter depth and to drop to four parts per million at the ice/water interface. This situation makes the likelihood of wintertime fish kills a distinct possibility. The Georgetown Lake Pre-Study (1973), report that "increased eutrophication of Georgetown Lake can only increase the winter-kill potential and create a habitat unfavorable for trout and salmon".

Georgetown Lake is reported by the Montana FRsh and Game Department to be the most heavily fished lake in Montana. There are currently about 100 summer resident units on the lake and 150 campground units. Along with fishing, the area is used for camping,picnicking, boating, horseback riding and trail cycling. Some cattle also graze the area. These activities have had a noticeable effect on the terrain of the region with erosion becoming more evident. The Georgetown Lake Pre-Study (1973) says that "shoreline erosion, roads and trails seem to be the primary contributors to sedimentation of the lake at this time. A good vegetative cover provides the best watershed protection.

Except during the period of ice cover nutrient concentrations are extremely low. There was no evidence of cultural enrichment or excessive plankton blooms. Most of the organic production in the lake is accomplished by rooted aquatic plants. The organic content and nutrient content of the bottom muds was closely correlated with the cycle of rooted aquatic plants. Upon death and decay of the plants there was an increase in the organic content of the mud and the phosphorus content. This continued until mid-winter when both fractions declined. The decline in mud phosphorus was correlated with the increase in phosphorus content of the bottom waters. Evidence gathered so far indicates the possibility of winter-kill due to oxygen-depletion is the most serious management problem of the lake.

FLINT CREEK

Van Meter (1974) conducted an investigation of metals in water and fish in the Flint Creek drainage. He found relatively high mercury levels that can be correlated directly with 19th Century silver mining activities in which mercury was used in silver processing. Mercury levels of 2 mg/l were found in Fred Burr Creek below the Rumsey Ore Processing Mill. The same high mercury concentrations existed in the water below the Granite Works on the small stream that tributory that flows through Philipsburg.

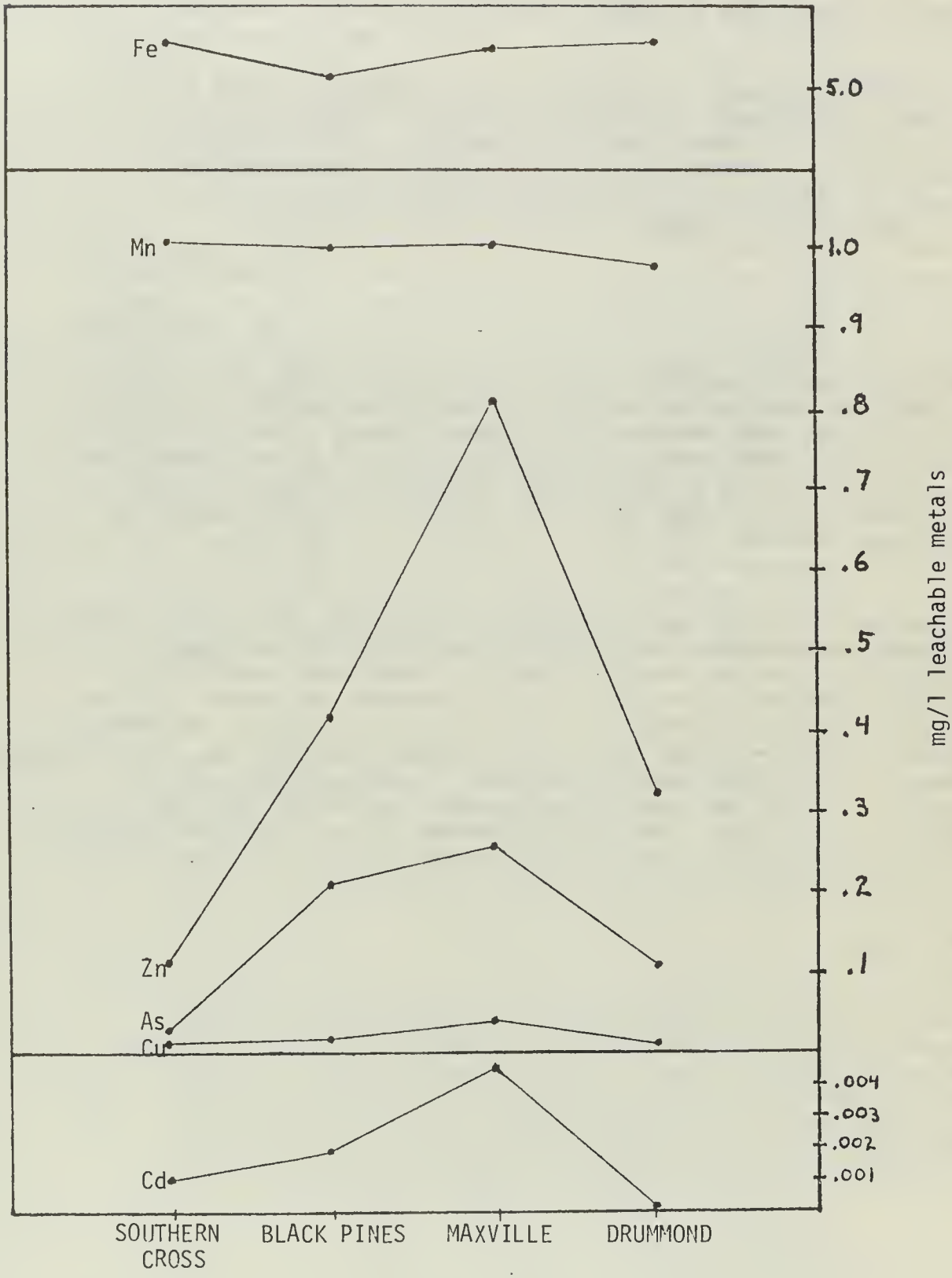


FIGURE 8. METALS IN THE STREAM SEDIMENT OF FLINT CREEK

The mercury concentration in fish tissue correlated directly with the distance from the mills.

Data collected by the Water Quality Bureau in 1974 show Flint Creek from Hall to Drummond to contain a significant concentration of iron and manganese, averaging about 0.75 and 0.25 milligrams per liter total recoverable iron and manganese, respectively. The metal content of the creek was not measured above Hall.

In a Water Quality Bureau stream sediment survey in May, 1974, one gram of stream sediment was added to one liter of distilled water. Five milliliters of concentrated distilled nitric acid was added to the flask. The sample was stored for six months prior to analysis. Total recoverable metals leached from the sediment were then analyzed (Figure 8). The increase of metals in the sediment between Southern Cross, which is near Georgetown Lake, and Maxville, 15 miles downstream, is probably the result of past silver milling and mining activities in the Philipsburg area. The Montana Fish and Game Department conducted a fisheries investigation of Flint Creek in June, 1972 to ascertain whether or not the classification of the stream below Philipsburg should be upgraded. They evaluated the population at three sections of the creek starting with one of them directly below Georgetown Lake, another near Maxville, and the third two miles above the confluence with the Clark Fork River. Rainbow and brook trout were abundant in the uppermost sections of the stream with brown trout and whitefish predominant from Maxville down. They did find several age groups in the station above the confluence with the Clark Fork indicating that propagation was better than marginal. As a result, all of Flint Creek was raised to a B-D1 classification by the State of Montana.

ROCK CREEK

The U.S. Forest Service conducted surveys on spawning bed gravel to determine its suitability for salmonoid egg development. These studies were initiated in the fall of 1969 and continued through the fall of 1973. Haugen (1974) found the "intergravel gravel dissolved oxygen and permeability readings were consistently above the values considered to limit salmonoid egg development".[1]

Rock Creek provides an environment for spring and fall spawning salmonoid species and is one of Montana's blue ribbon trout streams.

The University of Oklahoma, in conjunction with the U.S. Forest Service, has conducted water quality monitoring at 17 stations on Rock Creek and its tributaries from 1970 through 1973. Haugen (1974) of the U.S. Forest Service concluded that, "Test results [1]DO 7 parts per million and permeability 3,000 centimeters per hours

indicate that water quality of Rock Creek and those tributaries monitored were excellent and conform to the Montana water quality for B-D_1 waters criteria". There were year-to-year variations in the parameters such as turbidity, alkalinity, temperature and suspended sediment. However, these changes were reported to most likely be the result of variation in stream flow and not due to man's activities.

Willow Creek (a tributary to Rock Creek) runs through meadow land which is used extensively for agriculture and irrigation is commonly practiced in the valley and as a result, the ammonia concentrations were high. Total dissolved solids and alkalinity values were indicative of irrigated agricultural land. Both parameters increased significantly during the study period but the increase could not be tied directly to ranching practices because there was no measured increase in organics or nutrient load (Haugen, 1974).

BLACKFOOT RIVER

The Montana Fish and Game Department and the University of Montana initiated a chemical and biological water sampling program on the Blackfoot River drainage in 1968. Water quality sampling and analyses were done for 37 sites for a period of five years. As a result of this study, Spence (1975) describes the water quality of the Blackfoot River as follows: "Water quality was generally good in the Blackfoot River and its tributaries. Degraded water quality exists in extreme headwaters of the Blackfoot River due to acid mine drainage from the abandoned Mike Horse Mine and other tunnels."

Bear Trap Creek and Anaconda Creek form the headwaters of the Blackfoot River. Anaconda Creek is a high quality stream and contains cutthroat and brook trout, but Bear Trap Creek receives effluent from the Mike Horse Mine area, and as a result, is degraded by the acid mine drainage in that region. A good cutthroat population of fish was found in Bear Trap Creek above the mine drainage. No fish were found in the stream immediately below the confluence with mine drainage waters. Anaconda Company collected water samples in the area in 1972 and 1973 and the results showed high levels of metals, particularly zinc, entering the water system (Spence, 1975). No fish were found in the headwaters of the Blackfoot River above Pass Creek which enters the river two miles downstream from the source. Pass Creek does improve the water quality of the river but fish and bottom fauna remain depressed (near Pop's Place) about one mile below the confluence of Pass Creek. The Blackfoot River diversity index calculated from biological sampling indicates poor water quality at Pop's Place. The biota greatly improves between Pop's Place and Flesher Road (5 miles downstream) and further improves 9 miles downstream from Pop's Place at Hogum Creek. (Table 25) The similarity in chemical characteristics of the water at Pop's Place and Flesher Road indicates that some other factor must be responsible for the difference in biota observed. The high zinc and cadmium content found in stream sediment in the area suggests that sediment may inhibit the stream biota. Spence (1975) suggest that "Immature

insect forms living on this strata may accumulate these metals in their systems from direct contact or through ingestion of other food organisms which exist on the metal laden substrate. The result could be direct mortality of the more sensitive forms or mortality connected with inviable eggs during reproduction. Since trout also lay eggs in stream substrates during spawning, certain metals may have the same effect on them--increased mortality by absorption of the metals into deposited eggs".

TABLE 25. SPECIES DIVERSITY INDEX (SPENCE, 1975)

Station	Date	No of Species	No. of Individuals	Diversity Index
Blackfoot River at Pop's Place	8/20/71	16	161	2.42
	10/19/71	12	195	2.51
Blackfoot River at Flesher Road	3/19/71	32	1062	3.76
	8/20/71	32	1522	3.01
Blackfoot River at Hogum Creek	3/19/71	53	6024	4.01
	8/23/71	47	4522	3.56

Willow Creek enters the Blackfoot River one-half mile below Flesher Road. Mine drainage enters Willow Creek from Sand Bar Creek, which meets Willow Creek about three miles upstream from the Blackfoot River. Fish population comparisons above and below the confluence of Sand Bar Creek with Willow Creek suggests that Sand Bar Creek has a detrimental effect on the fish population. The influence of Sand Bar Creek is seen where Willow Creek enters the Blackfoot River. Fish population studies (Spence, 1975) indicate a reduction in water quality below the Willow Creek entrance. Additional study is needed in the Bear Trap Creek and Sand Bar Creek areas to establish the nature and extent of the deleterious effects of acid mine drainage on the Blackfoot River.

In recent years, the Anaconda Company has been performing exploration work in the Mike Horse Mine area. As a result, they have considered opening a 15,000 ton per day copper mining and milling operation (Coffin and Wilke, 1971). However, because of the recent low price of copper, they have no immediate plans beyond property maintenance and assessment drilling (The Anaconda Company, 1975). Spence (1975) warns that "proposed mining facilities have the potential for causing water quality problems in the Blackfoot River and some of its tributaries. A proposed tailings pond will cover a portion of an elk calving area. Fisheries and wildlife habitat will be eliminated by the open pit mine and other facilities. Increased human population in a small upper Blackfoot Valley will have an additional adverse impact on fisheries and wildlife areas. Subdivisions along the Blackfoot River will present problems with maintaining the natural stream course due to channel modifications and/or streambank protection for flood control." According to Spence, (1975)

Alice Creek is a high quality tributary with a good trout population. Landers Fork, however, is a poor stream for trout in the lower reaches. This may be due in part to the result of the 1964 flood which destroyed part of the meanderings and left the Landers Fork with a wide unstable channel, thus creating turbidity problems (Table 26). In June of 1974, the Water Quality Bureau made an aerial survey of the Blackfoot drainage, and at that time, Landers Fork appeared to contribute the majority of the sediment load to the Blackfoot River.

TABLE 26. TYPICAL DATA ON TURBIDITY OF BLACKFOOT RIVER AND MAJOR TRIBUTARIES (Spence, 1975)

Location	Date (1972)	Turbidity (JTU)	Flow (cfs)
Alice Creek at Highway 200	5/17	31	450
	5/19	13	240
	5/24	27	190
*113	6/3	4.9	215
	AVERAGE	19	
Blackfoot River at Hogum Bridge	5/17	42	900
	5/31	11	509
*111	6/3	6.4	463
	6/7	3.8	309
	6/9	3.1	279
	AVERAGE	13	
Landers Fork	5/31	120	High, muddy
	6/3	220	+2,000
*107	6/5	150	High, muddy
	6/7	130	High, muddy
	6/9	120	High, muddy
	AVERAGE	150	
Blackfoot River at Dalton Mountain Bridge	5/17	100	2,475
	6/3	170	2,950
	6/5	150	2,800
*96	6/7	120	2,625
	6/9	130	2,625
	AVERAGE	130	
North Fork Blackfoot River at Highway 200	6/3	150	High, muddy
	6/9	130	Flooding, muddy
	AVERAGE	140	
*52			

*River miles above mouth.

The North Fork of the Blackfoot River also contributes to the sediment load in the Blackfoot River (Table 26). The sediment load is primarily the result of natural causes and is not due to the influence of man.

Chamberlain Creek enters the Blackfoot River about 45 miles above the mouth. The West Fork of Chamberlain Creek was intensively logged by the Anaconda Company in the 1940s and 1950s. Since then, the U. S. Plywood Company, who now owns the property, has leased the ground for cattle grazing. The Bureau of Land Management (BLM) reports the area to be continually overgrazed (J. Barnum, Personal Communications, 1975) and as a result, the BLM has measured runoff turbidities around 100 JTUs during spring runoff.

Elk Creek reaches the Blackfoot River 28 miles from the mouth. Gold dredging operations in the headwaters have caused occasional sediment problems downstream. The roadway that follows the stream adds to the problem, especially during spring runoff when frequent road washouts occur (Barnum, Personal Communications, 1975). The lower reaches of stream flows through the Greenough Valley, a farming area.

Union Creek flows into the Blackfoot River 12 miles above the mouth. Union Creek runs through the Potomac Valley which is agricultural land used for cattle grazing and hay production. Personnel of the Water Quality Bureau and BLM examined these streams on April 9 and 10, 1974. Braico (Personal Communications, 1975) reported apparent poor land use practices with headcutting all along the stream. Very little stabilization bank vegetation was evident as viewed from the road. Stream channel alterations existed in the upper part of the valley as a result of poor construction practices. Both Elk Creek and Union Creek drain similar regions and therefore have similar characteristics. Both streams carry heavy sediment loads, especially in the spring of 1969 when turbidities of over 200 JTU's were measured by the Montana Fish and Game Department. Personnel from BLM report that Union Creek runs muddy all year. The dissolved solids in Union Creek measured by the Fish and Game Department averaged over 200 milligrams per liter which was the highest average measured during this study for any of the Blackfoot River tributaries (Spence, 1975). Spence (1975) reports that Union Creek does not have a good sports fish population and suggests that the excess turbidity, dissolved solids or water temperature from irrigation practices may be responsible.

Logging operations in the Blackfoot River Valley have had a marked effect on such creeks as Keep Cool Creek, Beaver Creek, Arrastra Creek and Gold Creek. Keep Cool Creek has recently been extensively clearcut. Fortunately, the slopes of the drainage are gentle and the soil fairly stable. Therefore, the impact of logging on the creek has not been severe. Beaver Creek also has been extensively logged; however, the gradient is steeper and as a result, it carries a considerable silt load (Weisel, 1974). Arrastra Creek has been heavily logged in the last few years. Sections of the creek go underground and presumably the resulting percolation through the

gravel filters much of the silt from the creek before it surfaces in the lower reaches (Weisel, 1974).

In conclusion, the Blackfoot River generally has good water quality with free flow from the source to the mouth. The influence of man on the stream has been small except in the Upper Blackfoot area where mining has played a significant role. Mining could cause additional water quality problems if mining properties are developed in the drainage.

On June 20, 1975, a mine tailing pond near the Mike Horse Mine on Bear Trap Creek (the headwaters of the Blackfoot River) failed. Unusually heavy rains caused a landslide that blocked the pond outlet and caused overtopping of the pond. Water overtopping the pond rapidly eroded a large gap in the dam and the entire stream entering the reservoir began discharging through the gap. The eroded material is from the mining operation and is fine-grained, grey colored, pyritic tailings that will react with water to release an acid and toxic metals. The eroded materials caused a very high concentration of suspended sediment and very turbid stream conditions. The impact on the stream is not fully known but it is expected that the stream biological community will be damaged or destroyed for possibly many miles downstream from the dam.

CLEARWATER RIVER

In general, water quality in the Clearwater River is good. During a study of the area by Streebin (1974) 1972 and 1973, dissolved oxygen content in the river remained near or above saturation at all 17 sampling stations and nutrient concentrations generally were low. There was significant sediment during spring runoff but the stream was relatively clean during the remainder of the year. High suspended sediment measurements were recorded in the river between Rainy Lake and Clearwater Lake (Figure 8). At this point, the river flows through a flat sand-silt area where it picks up large quantities of suspended sediment. Most of this material is deposited in Rainy Lake where turbidity is reduced. Alkalinity of the Clearwater River generally decreases downstream probably due to the dilution by water from tributary streams. Logging practices in the area have had an adverse effect on the water quality in the drainage. Richmond Creek, Deer Creek and the West Fork of the Clearwater River have a significant change in water quality as a result of logging. The COD, tannin and lignin average for these streams was measured by Streebin (1973) to be almost twice as high as for other tributaries sampled in the drainage. Turbidity was over one and one-half times the average. Streebin states, "A great portion of the West Fork has very steep banks and the upper end is eroded badly, due to poor logging practices by Burlington Northern Railroad. Seven and eight years ago, they logged up to the creek and skidded logs down the channel."

"If the channel is disturbed, it will begin to meander excessively. This causes instability of the banks for many years to come, making new growth of foilage difficult". The Deer Creek area has recently been clear cut by Burlington Northern in many places to within a few feet of the creek. The same problem exists in the Richmond Creek area (Streeben, 1973).

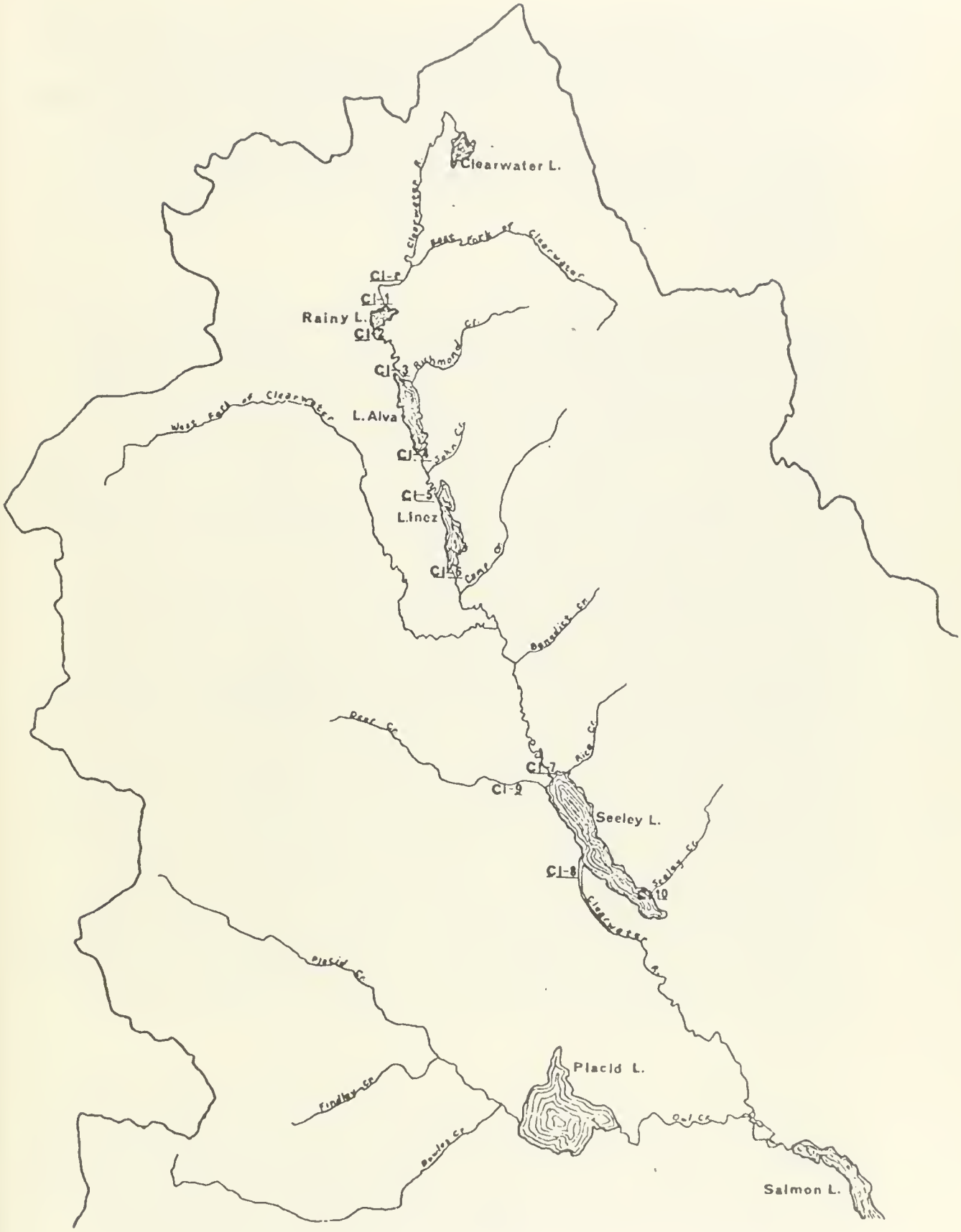


FIGURE 9. CLEARWATER RIVER DRAINAGE
(Streebin, 1973)

Agricultural practices in the lower part of the drainage also have an adverse effect on water quality, most notably in Blanchard Creek which joins the Clearwater River near Clearwater Junction. The Placid-Blanchard Planning Unit (1973) reports, "Below the confluence of the North Fork with Blanchard Creek, scouring is evidence as are numerous debris jams. Habitat deterioration of this area consists of sparse bank cover which results in slumping of the streams and sedimentation. This deterioration is caused primarily by cattle."

PLACID LAKE

Placid Lake is an 11,085 acre lake located on Placid Creek in the Clearwater River drainage basin (Figure 8). Compared with lakes on the Clearwater River, water quality in Placid Lake is poor. Placid Lake receives most water oriented recreational use in the area. The shoreline is mainly owned by U.S. Plywood with some state and private owned land on the lakeshore but no national forest land. The lake is eutrophic, and as a result, has dissolved oxygen depletion problems. The water also has more color than other lakes in the area resulting in a higher temperature and subsequently lower dissolved oxygen concentration. Dissolved oxygen in Placid Lake drops fairly low as soon as the ice goes out in the early spring and after summer stratification occurs. Dissolved oxygen in the deep water drops to around two parts per million or less and the low dissolved oxygen situation exists until autumn when mixing occurs (Juday, 1974). During July and August, 1974, Juday found very abundant blooms of blue-gree Aphenizomeon and Nostoc. Streebing (1974) reported prolific blooms of Aphenizomeon flos-aquae in the lake during the summer of 1972. This species produces a toxin causing disagreeable taste and odor and can be toxic to fish. All of the lakes in the Clearwater River chain appear to have a sufficient supply of nutrients available for A. flos-aquae blooms. The primary difference between Placid and the other lakes is temperature. The higher temperature in Placid Lake is due in part to the color and retention time. Placid Lake homeowners maintain a dam on Owl Creek which raises the water level about five feet. This increased retention time and increased surface area result in higher summer water temperatures. An irrigation diversion on the North Fork of Placid Creek results in a decreased flow into Placid Lake. The irrigation diversion has a capacity of 125 cfs and is diverted to the Jocko Lakes via a 2½ mile canal. Most of the diversion is of flood waters in the early spring.

In 1974, Juday (1974) ran bacterial tests on Placid Lake. Bacterial concentrations generally were quite low except for a couple of occasions in stations near campgrounds at the south end of the lake. Juday (1974) attributed these readings to camping and aquatic activities and suggests that it may be a good idea to ban camping between the road and the lake to minimize reoccurences of high counts. Placid Creek is a major tributary to the lake. The stream is of relatively good size and provides good habitat to pan-sized

trout. However, grazing of cattle on private land in the area has contributed to bank damage and water quality deterioration (Placid-Blanchard Planning Unit, 1973).

IX. WASTE DISCHARGE PERMITS

The Montana State Program for issuing waste discharge permits is operated under authority of the Montana Water Pollution Control Law. Statutory authority to apply and enforce state compliance schedules in state permits are Sections 69-4806 (3), 69-4804.2 (1) (f) (1) and (2), 69-4820, 69-4820.1, and 69-4823, Revised Codes of Montana, 1947. The applicable rule is existing MAC 16-2.14 (10) -S14460, Montana Pollutant Discharge Elimination System (MPDES), Section (2) (b) (ii) effective March 8, 1974. Six municipal, six industrial, and one agricultural waste discharge permits have been issued by the state in the Upper Clark Fork River Basin (Table 27). All municipalities on compliance schedules are expected to meet secondary treatment requirements by July 1, 1977. Facility descriptions and effluent characteristics are discussed in Section VI.

The U. S. Environmental Protection Agency (EPA) issues waste discharge permits for federal facilities in Montana.

Federal permits are issued pursuant to the National Pollutant Discharge Elimination System (NPDES) created by the Federal Water Pollution Control Act Amendments of 1972 (FWPCAA of 1972). To eliminate the duplication of effort which formerly existed, Montana was given the authority to administer the NPDES Program in Montana on June 10, 1974. Section 402 of the FWPCAA of 1972 provides that states with adequate water pollution control program elements may apply for and receive authority from EPA to issue permits under the NPDES in their own states. Montana made the necessary revisions to the state water pollution control laws during the 1973 legislative session to provide the statutory authority for administration of the NPDES Program in Montana. In addition, the Board of Health and Environmental Sciences adopted a rule entitled the Montana Pollutant Discharge Elimination System (MPDES). The MPDES rule provides the additional program elements needed by the state to comply with rules and regulations promulgated by the administrator of EPA pursuant to Section 304 (h) of the FWPCAA of 1972. Section 304 (h) relates to the state program elements necessary to administer the NPDES Program.

TABLE 27. MPDES PERMITS IN THE UPPER CLARK FORK RIVER BASIN

FACILITY	MPDES PERMIT NO.	DATE ISSUED	EXPIRATION DATE	COMPLIANCE SCHEDULE
Drummond, MT Sewage Treatment Lagoon	MT 0020281	3/19/74	12/31/76	Yes
Deer Lodge, MT Sewage Treatment Lagoon	MT 0022616	8/26/74	12/31/76	Yes
Philipsburg, MT Sewage Treatment Lagoon	MT 0021903	3/22/74	12/31/76	Yes
Silver Bow Metro Butte, MT Secondary Sewage Treatment	MT 0022012	3/28/74	12/31/76	Yes
Warm Springs State Hospital Warm Springs, MT Sewage Treatment Lagoon	MT 0020010	4/3/74	12/31/76	Yes
Galen State Hospital Galen, MT Secondary Sewage Treatment	MT 0021431	7/30/74	6/30/76	None
Anaconda Company (Continental East Pit) Butte, MT Industrial	MT 0022926	8/26/74	6/30/79	None
Anaconda Company Warm Springs, MT Industrial	MT 0000183	1/8/74	6/30/79	Yes
U.S. Plywood Bonner, MT Sewage & Industrial	MT 0000205	11/27/73	1/1/77	None
Butte Water Co. Butte, MT	MT 0001058	12/13/73	7/1/77	None
CMSTP & P R.R. Deer Lodge, MT	MT 0000043	2/21/74	7/1/77	None
Anaconda Washoe Fish Hatchery State Fish & Game	MT 0000141	11/29/73	6/30/77	None
Anaconda Company Butte, MT Industrial	MT 0000191	11/2/73	7/1/76	None

X. WASTE LOAD ALLOCATION

To prevent point source wastes from exceeding Montana's stream standards, loads to streams are allocated including an allowance for possible future changes in wastes and stream quality. All streams in the basin are disignated effluent limited except the following segments.

(1) Clark Fork River from Cottonwood Creek (Deer Lodge) to the Blackfoot River.

(2) Blackfoot River downstream to mouth of Alice Creek.

(3) Landers Fork of the Blackfoot River.

(4) Union Creek.

(5) Bear Trap Creek from Mike Horse Dam downstream to the Blackfoot River.

(6) North Fork Blackfoot River.

(7) Placid Lake.

(8) Georgetown Lake.

The Clark Fork River downstream from Cottonwood Creek has been influenced by excessive algae growths in the summer. As discussed in Section VIII of this report, the stream appears to be receiving enough nutrients to cause these undesirable aquatic growths. There are a number of municipal dischargers in this segment and some nutrient discharges in the adjacent upstream segment. Further nutrient and algae investigations are needed to confirm the problem and probably problem causes. If needed, a waste load allocation will then be developed for this segment.

The Blackfoot River from its headwaters downstream to the confluence with the Landers Fork is significantly impacted by toxic metals flowing from abandoned mines. These toxic metals have supressed biological conditions in the stream for a number of years. It is doubtful that the waters will meet the states B-D1 classification since there may not be propagation of salmonoids in this segment. As described in the water quality section of this report, the substrate in the Upper Blackfoot River may be unfavorable for fish reproduction. A dam, used to store tailing from the Mike Horse Mill, (uppermost end of the stream), failed in June 1975 and about 100,000 tons of metal bearing tailings were deposited on the stream bottom probably further inhibiting biological activity. There are no discharges in the stream segment that can be regulated or allocated, thus no waste load allocation is possible.

Landers Fork of the Blackfoot and the North Fork of the Blackfoot are designated as a water quality limited segments due to excessible sediment. The sediment load appears to be the result of natural erosion in the watershed. There are no dischargers to these streams, thus, no waste load allocations can be made.

Union Creek (tributary to the Blackfoot River about 12 miles above the mouth) is classified as a B-D1 stream but is designated as a water quality limited segment. This stream has a high sediment load probably due to grazing and irrigation practices and probably is not suited for propagation of salmonoid fish. There are no point dischargers in this segment thus no waste load allocation can be made. Additional work is needed to determine the cuases and possible corrections for this sediment problem.

Silver Bow Creek is classified as an E-F stream. With the exception of occasionally excessible pH, the creek waters meet this classification. The improved waste treatment system of the Anaconda Company - Butte Operation should allow the stream to consistantly meet the E-F classification. This stream, however, probably will not meet the E.P.A. 1983 goal of propagation of fish and providing recreation. It is anticipated that this stream will be reclassified in the future and it is possible that the stream may be redesignated as water quality limited if it does not meet the future classification.

Bear Trap Creek receives acid mine drainage from the Mike Horse mine. This effectively destroys the stream fishery. This stream is classified as a B-D1 stream. However, there is no possibility for growth and propagation of salmonoids in the stream. This is an old acid drainage problem and it is doubtful if the problem can be economically corrected.

North Fork Blackfoot River is classified as a B-D1 stream. Excessive sediment however inhibits growth and reproduction of fish. The sediment problem is almost entirely natural thus no waste load allocation is possible.

Placid Lake is eutrophic and as a result has oxygen depletion problems. The lake is classified as a B-D1 water but the growth and propagation of salmonoids is inhibited. Cause of the eutrophic condition is unknown but may be influenced by summer home developments. A more detailed investigation is needed before the necessity of a waste load allocation can be determined. The eutrophic condition of the lake probably is mostly a natural phenomena.

XI. MANAGEMENT STRATEGY AND PLAN

The objective of water quality management is to maintain or enhance the quality of waters within the basin. To accomplish this, management programs and plans must be developed and implemented within the basin. After development and implementation, waters and wastewaters in the basin must be checked to determine actual effectiveness of the management program. Water quality management is an interative process; that is, a plan must be followed, the results checked, the plan modified, and the results again checked. A management strategy contains a number of elements. These are:

1. Permits

   State and federal pollutant discharge permits are a basic tool in regulating the discharge of effluents to state waters. All discharges under the permit authority, either are or will be permitted or eliminated. The permit program regulates the quantity and quality of discharges of municipal and industrial wastes and certain agricultural wastes, including discharges from confined feeding operations and from irrigation drainage systems. The discharge permit also is used to regulate effluent from new or expanded discharges. As stream quality data are obtained, the permit can be used to insure that discharging effluents do not cause streams to exceed state water quality standards. All dischargers will be required, under the permit program, to achieve best practicable control technology not later than July 1, 1977. All publicly owned treatment works must achieve secondary treatment by July 1, 1977.

2. Intensive Surveys

   Intensive water quality surveys are conducted for waters in the basin that have water quality problems. Objectives of intensive surveys are to determine pollution causes and potential means of elimination or abatement of pollutants. As additional water quality problems are identified within the basin, intensive surveys will be made. Intensive surveys also are conducted to determine the impact of specific wastewater discharges, land practices, or water treatment facilities that are installed in the basin.

3. Monitoring

   Monitoring includes a number of activities that provide measurement of chemical, physical and biological quality of water and changes in quality. Monitoring includes:

   (a) self-monitoring required by dischargers that are under the Pollutant Discharge Elimination System permit program;

   (b) compliance monitoring by the Water Quality Bureau and the EPA to ensure that permitted discharges are in compliance with allowable limits;

(c) periodic sampling and analysis of water at selected stations;

(d) aerial and ground observations of basin waters and practices or facilities that effect water quality;

(e) the use of continuous water quality recording instrumentation to obtain a continuous record of selected water quality parameters;

(f) short-duration surveys of stream segments to determine changes in quality in streams as the water progresses downstream;

(g) evaluation of water quality data to determine trends and to identify problems.

The basic objective of the monitoring effort is to determine the status of water quality and to determine variations in water quality. The monitoring network also is useful for determining the impact of activities within the basin that influence water quality. Such activities include those that potentially degrade water quality, such as logging, mining, and certain agricultural practices; and those activities that may enhance water quality, such as installation of improved treatment facilities.

4. Facilities construction, operation, and maintenance.

Federal and state grant programs are available to assist municipalities in the construction of sewage treatment facilities, which include outfall and interceptor sewers. Such facilities provide improved treatment of wastewaters and reduce the impact of wastewaters on the receiving water body. An integral part of the waste treatment facility program is adequate operation and maintenance of the facilities after construction is completed. The state requires that all operators be certified and the state provides on-the-job training and annual schools for operators.

5. Operation and maintenance.

Periodic inspections are made of municipal and industrial wastewater treatment facilities in the basin. The objective of operation and maintenance inspections is to ensure that waste treatment facilities are operated in a manner that provides the best possible treatment.

6. Information and Education.

Information is made available to the public through bureau publications, talks, technology transfer seminars, and through answering inquiries. Public hearings and environmental impact statements are presented for important or

controversial issues in the basin. Information and educational efforts are informing the public of water quality conditions in the basin and factors that can degrade water quality. This effort stresses development of a pollution prevention attitude.

7. Regulations and Guidelines.

To prevent water quality degradation within the basin, regulations and guidelines that relate to water quality will be made available to residents of the basin through state and county organizations. This includes regulations that influence water and wastewater from subdivisions and private and public water and wastewater facilities. In addition, existing regulations may be changed or updated to control activities within the basin that will degrade water quality. The Department of Health and Environmental Sciences in cooperation with other agencies, will develop guidelines that will abate or eliminate pollution resulting from storm drainage, storm sewer discharges and non-point sources, including irrigation practices, road building, construction, logging practices, overgrazing and other practices. Land use is recognized as a dominant factor controlling water quality in the basin. Those activities which influence land use will be examined to determine how water quality degradation due to improper land uses can be eliminated or abated.

8. Enforcement.

Violations of Montana's laws, rules, or permits are investigated and are subject to injunction, civil penalties, or criminal penalties. The rules and regulations upon which enforcement is based are periodically reviewed and updated to insure that Montana's laws and regulations are adequate and can be properly enforced.

9. Program Coordination.

Montana's Water Pollution Control Program will be coordinated with other state, federal and local agencies to ensure that the activities of these groups receive adequate information with respect to their water quality related activities. This includes review of proposed programs, laws, regulations and proposed technical investigations that relate to water quality.

The elements of basin water quality management described above generally are applicable to all basins. Specific steps that will be taken in the Upper Clark Fork Basin are:

1. Permits.

Permit conditions and progress in meeting compliance schedules

will be reviewed for all dischargers in the basin in FY 1976. All permits will be reviewed prior to expiration to determine what revisions are needed for the reissued permits. All dischargers that have not received permits, but are under the NPDES or MPDES, will receive permits in FY 1976.

2. Intensive Surveys

In FY 1976 intensive surveys are planned for Silver Bow Creek and the Upper Clark Fork River. As additional water quality problems are identified and as funding is available, additional intensive surveys will be conducted.

3. Monitoring

See Section XII (Monitoring and Surveillance) for specific basin strategy and plans.

4. Facilities Construction, Operation and Maintenance.

Inadequate municipal sewage treatment facilities are ranked according to priority (Appendix D) and will be upgraded to meet secondary treatment and any more stringent limitations necessary to meet water quality standards by July, 1977. Industrial treatment of wastewater discharges will meet best practicable treatment by July, 1977. Some EPA and state grant funds will be available for municipal sewage facilities. Sewage treatment plant operator training and the operators school will be available for the basin.

5. Operation and Maintenance

At least one inspection will be made annually of each major municipal sewage treatment facility in the Upper Clark Fork basin. Critical installations will be provided additional inspections when needed and facilities with special operation and maintenance problems will be provided with technical assistance. Minor municipal dishcargers will be inspected as funds on man power allow.

Major industrial dischargers are examined at least twice per year and minor dischargers are examined as needed and as man power and funding are available.

6. Information and Education

The general bureau information and education program will be utilized in the basin. No specific basin programs are planned for the next year.

7. Regulations and Guidelines

During the next year, the regulatory framework for water pollution control will be reviewed by the bureau attorney. The adequacy of the regulations to prevent pollution will be assessed.

8. Enforcement.

Enforcement actions will be taken as needed for prosecution of violations of the state's water pollution laws and regulations.

9. Program Coordination.

Federal, state and private organizations that have water quality related actions in the basin will be informed of the Bureau's efforts and will be requested to furnish information on these basin programs. The Upper Clark Fork River drainage is being considered for designation as 208 area.

XII. MONITORING AND SURVEILLANCE

Water quality monitoring and surveillance programs represent a major investment of time and funds. Such programs should obtain the needed information at least cost. To properly design a cost-effective monitoring system, a number of factors must be considered including:

1. Adequacy of baseline data in the basin;

2. Status of the stream as a receiving water for pollutant discharges;

3. Data needs for point source discharges under state and federal permit programs;

4. Existing and potential water quality problems;

5. Data needs for enforcement actions;

6. Available time and funding;

7. Existence of other water quality data collection programs in the area.

Flexibility in scope and intensity is an important aspect of a proposed program. A variety of factors can influence an area's water quality; these include industrial, municipal, and agricultural developments, federal and state regulations, and water transfers. With the range of developments that can occur in a basin, a long-term management strategy cannot be efficiently developed. Water quality surveillance and monitoring is directed at short-term conditions (up to five years in the future) and is revised annually.

Monitoring and surveillance recommendations are presented in this report. The detailed basin monitoring and surveillance program is developed by the Water Quality Bureau as part of the annual water pollution control program plan. Monitoring and surveillance activities are conducted by a variety of organizations including communities and industries, federal and state agencies, private individuals and organizations. Commonly acute problems such as toxic conditions causing fish kills, oil spills, etc. are recognized by basin residents or persons working in the basin.

The following is the recommended monitoring program for the Upper Clark Fork Basin.

1. Compliance Monitoring.

   The following municipal point discharges should be monitored to check compliance with MPDES permit conditions.

   Drummond
   Deer Lodge
   Philipsburg
   Silver Bow Metro
   Warm Springs State Hospital
   Galen State Hospital

Suspended solids, BOD_5, fecal coliforms, and flow should be monitored in all municipal discharges; residual chlorine should be measured where chlorination is provided. Nutrients should be monitored at the Deer Lodge discharge due to the trophic condition of the Upper Clark Fork River drainage. Municipal water treatment plant discharges will be monitored for aluminum, suspended residue, turbidity, flow, pH, and residual chlorine.

Similarly, it is recommended that the following industrial discharges be monitored by the Water Quality Bureau to check compliance with MPDES permit conditions:

Anaconda Co. (Continental East Pit)
Anaconda Co., Butte
Anaconda Co., Warm Springs
U.S. Plywood
CMSTP and P R.R.
Washoe Fish Hatchery

Frequency and parameters to be monitored for irrigation return flows have not, as of yet, been defined. Feedlots are basically designed as non-discharging facilities.

2. Self-monitoring

All waste dischargers under MPDES permit are required to periodically sample and analyze their wastewater and report these results to the Bureau and the Environmental Protection Agency. The parameters to be monitored are specified in the conditions of the permit.

3. Water Quality Surveillance Network

The water quality surveillance network is composed of water quality sampling stations on streams, waterbodies and groundwater, shown in Table 28.

TABLE 28. RECOMMENDED WATER QUALITY SURVEILLANCE NETWORK

Stream	Site	Parameters and Frequency
Silver Bow Creek	Confluence with Blacktail Creek	pH metals, flow Specific conductivity (monthly)
	Opportunity	pH metals, flow Specific conductivity (monthly)
	Lower pH Shack	pH metals, flow (monthly), nutrients, Specific conductivity (continuously)
Horse Canyon Creek	above Butte	pH metals, coliform Specific conductivity (quarterly)
Basin Creek	Confluence with Blacktail Creek	Coliform (quarterly)

TABLE 28 (CONT.)

Stream	Site	Parameters and Frequency
Mill-Willow Creek	Above Warm Springs Ponds	Metals (Monthly)
	Below Warm Springs Ponds	Metals (Monthly)
Warm Springs Creek	Above Opportunity Ponds	Metals (Monthly), Nutrients
	Below Opportunity Ponds	Metals (Monthly), Nutrients
Clark Fork River	Deer Lodge	Metals, temperature (Monthly), Nutrients
	Above Rock Creek	Dissolved (Continuously during late summer) oxygen
Blackfoot River	Pop's Place	Metals, conductivity (Monthly)
Willow Creek	Confluence with Blackfoot River	Metals, conductivity (Monthly)
Landers Fork	Confluence with Blackfoot River	Turbidity, conductivity (Monthly)
Union Creek	Confluence with Blackfoot River	TDS, conductivity (Monthly) Turbidity (During runoff)
Georgetown Lake	Representative	Dissolved oxygen Profile (Spring time before ice goes off & late summer before overturn)
Placid Lake	Representative	Dissolved oxygen (Spring time before ice melts & fall before overturn)
		Algae identification (late summer)
		Temperature Profile (late summer before overturn)

The actual basin surveillance program is described in the bureau annual water pollution control program plan. Details of sampling frequency and parameters also are described in this plan.

Biological assessment and water quality runs will be carried out at selected sites in the basin. Biological assessments involve periodic quantitative and/or qualitative benthic organism assessments. Water quality runs involve an intense instream survey of a few water quality parameters at a large number of stations. The

sampling is designed to measure changes in stream quality as the water moves downstream. Sites selected for these evaluations are described in the Bureau's annual pollution control plan.

4. Aerial and Ground Surveys.

   Examination of streams and water bodies is done as part of the routine bureau visits to the basin. Other agencies and organizations also commonly notice stream conditions during their basin trips. Detailed aerial surveillance and actual stream examination on foot or by boat is required for selected problems. An annual detailed survey of Silver Bow Creek should be made and aerial surveillance of the Clark Fork River in late summer should be made to check algae conditions.

5. Data Interpretation and Analysis.

   Surveillance and monitoring activities develop water quality data that must be compared with previous data, water quality standards, permit conditions, etc. Results of water quality testing must be analyzed and interpreted to understand temporal and spatial changes in water quality and determine if the sampling network is adequate to meet program objectives.

XIII. MUNICIPAL FACILITIES INVESTMENTS

Several municipal facilities are in need of upgrading to meet secondary effluent standards, these are: Drummond, Deer Lodge, Philipsburg, and Warm Springs. Projected cost estimates have not been calculated for these facilities to date, but have been made for needs at the Silver Bow Metro and Galen State Hospital sewage treatment facilities. About $3,300,000 will be needed at Silver Bow Metro to revise secondary treatment and to correct sludge handling and disposal problems.

Relative ranking of state-wide projects are given in Appendix D.

XIV. PLANNING NEEDS

The planning needs for the basin relate almost exclusively to land use considerations. The three most significant problem sources as related to water quality are agriculture, lumbering, and mining. These activities have lead to the introduction of increased sediment, dissolved solids and metals into state waters. Table 29 lists the water sources in the basin that have been found to have significant water quality problems. This table does not include all problems but only includes major problems as determined during this project.

Table 30 lists additional intensive water quality surveys that should be undertaken in the basin. These studies are related to problems in the basin and are listed in order of importance.

TABLE 29. SUMMARY OF WATER QUALITY PROBLEMS IN UPPER CLARK FORK RIVER BASIN.

Problem	Water Body and Area Affected	Status	Potential for Correction	Methods of Correction
Metals Dissolved solids	Mill-Willow Creek Bypass, 2 miles	Continuing seepage problem; needs further investigation to determine dynamics of problem.	Unknown	Must determine method to keep the ponds from seeping or collecting seepage before entering stream.
Metals Dissolved solids Dewatering	Warm Springs Creek (Deer Lodge Co.) 10 miles	Seasonal dewatering problem below Anaconda due to irrigation, continuing Anaconda Company pond seepage problem.	Fair to Poor	Better flow regulation and more efficient use of water. Seepage control.
Dewatering	Mill Creek, 5 miles	Seasonal dewatering	Fair	More efficient water use.
Metals	Clark Fork River above Deer Lodge, 20 miles	Continuous discharge of metals from Anaconda Company ponds; however, biota have shown recovery in recent years. Sediments may be toxic salmonoid propagation for many years.	Fair	Reduce metal discharge, additional investigation needed.
Dissolved oxygen, elevated temperature	Clark Fork River above Rock Creek, 100 miles	During low flow period in late summer with O_2 sag due to heavy algal blooms.	Poor	Reduction of nutrient input. Dissolved oxygen sag is common in eutrophic waters; however, elevated temperatures are partly caused by channelization which reduces shade areas.

TABLE 29 (CONT.)

Problem	Water Body and Area Affected	Status	Potential for Correction	Methods of Correction
Metals	Silver Bow Creek, 40 miles	Continuous discharge of heavy metals from Anaconda Company, storm sewers, metro, nonpoint sources and stream sediments.	Poor	Reduce discharge by identifying and reducing point sources. Additional investigations needed.
Metals	Beartrap Creek below Mike Horse Mine	A continuous problem due to acid mine discharge from Mike Horse Mine.	Poor	Treatment of the drainage prior to entry in Beartrap Creek or sealing of mine.
Dewatering	Browns Gulch, 15 miles	Seasonal problem	Fair to Poor	More efficient water use.
Coliform, undetermined effects of Anaconda Company Continental East Discharge	Horse Canyon, 2 miles of stream	Coliform problem from septic tanks, likely to be continuous but varies with water table.	Good	Sewers Anaconda Company plans to eliminate mine discharge in late 1975.
Coliform	Basin Creek, 1 mile	High coliform counts have been recorded in metropolitan Butte. Sources should be located.	Good	Find sources and eliminate.
Sediment	Landers Fork of Blackfoot River 10 miles	Seasonal problem due to natural erosion of streambanks.	Poor	Bank stabilization. Stream rerouting. Economically difficult.

TABLE 29 (CONT.)

Problem	Water Body and Area Affected	Status	Potential for Correction	Methods of Correction
Sediment	Chamberlain Creek 5 miles	Seasonal problem due to past logging operations and present grazing practices.	Fair to Good	Better grazing practices to allow reestablishment of bank vegetation.
Sediment Dissolved solids	Elk Creek. 5 miles	Gold Dredging in upper reaches and irrigation in valley causes problem.	Fair	Better control of dredging and improved irrigation practices.
Sediment Dissolved solids	Union Creek, 10 miles	Agriculture and irrigation.	Fair	Better agricultural and irrigation practices.
Sediment	Keep Cool Creek, 5 miles	Recent clearcut logging and resultant road building have caused problem.	Fair to Good	Bank and land stabilization in erosive areas.
Sediment	West Fork Clearwater River Deer Creek Richmond Creek	Poor logging practices have caused erosion.	Fair	Bank and land stabilization in erosive areas.
Sediment	Blanchard Creek	Cattle have caused bank stabilization problems.	Good	Control cattle access to creek.

TABLE 29 (CONT.)

Problem	Water Body and Area Affected	Status	Potential for Correction	Methods of Correction
Dissolved oxygen	Georgetown Lake	Intense land and water use in the area and the lake shallowness have caused eutrophic conditions with winterkills of fish.	Poor	Needs investigation to determine if there are feasible control methods.
Dissolved oxygen, taste and odor producing blue-green algae blooms	Placid Lake	Dissolved oxygen drops to very low levels in deep water during summer stratification and again during the winter. Summer blooms of *Aphenizomion flos-aquae* have recently occurred.	Poor	Reduced summer temperatures believed responsible for the algae blooms.

TABLE 30. ADDITIONAL STUDIES RECOMMENDED IN THE UPPER CLARK FORK RIVER BASIN.

1. Colorado Tailings - Silver Bow Creek.

   Additional study is needed to determine the total contribution of the Colorado tailings area on the metal load in Silver Bow Creek. Preliminary studies show the tailings contribute the majority of iron, copper and zinc load reaching Silver Bow Creek in the Butte area. The study should investigate the feasibility of eliminating the load input to the creek. This study relating to the metal problem in Silver Bow Creek (Table 29).

2. Heavy metal loads - Silver Bow Creek.

   A heavy metal load study is needed to confirm preliminary data compiled for the waste load allocation study. This data showed total heavy metals to increase dramatically downstream; however, no dissolved metal data were available to compare with totals. Diebold (1974) in laboratory studies found the sediment to adsorb dissolved metals which means that dissolved metals should decrease downstream. This theory needs substantiation.

3. Salmonoid Propagation Study in the Clark Fork River above Deer Lodge so that it can be ascertained whether or not that reach of the river can be upgraded to C-D_1 classification.

4. Silver Bow Creek Bypass Study.

   An investigation should be undertaken to determine under what conditions Silver Bow Creek could bypass the Warm Springs Pond without violating water quality standards.

5. Seepage problem in Warm Springs and Opportunity Ponds (Anaconda Company treatment system).

   Investigate the location, extent and methods of alleviating seepage from the Anaconda Company treatment ponds and determine the influence of the seepage on the water quality of state waters in the area.

6. Algae Blooms - Clark Fork River

   Further investigation of the Cladophera blooms below Deer Lodge to determine effect of nonpoint and point sources on growth potential and evaluate the effect of the blooms on water quality.

7. Biota depression - Blackfoot River.

   More study is needed to determine the exact causes of the depressed biota above Flesher Road. This study should investigate the influence of seepage from the Heddleston mining

district and the influence of heavy metals in stream sediment on the benthic conditions of the river in that area.

8. Benthic investigation - Silver Bow Creek.

   Anaconda Company dramatically reduced their metal load contribution to Silver Bow Creek in 1972. An annual suvey of the stream biota should be conducted at a select number of stations to monitor changes in water quality.

9. Mercury contamination in Fred Burr Creek.

   Fish tissue studies have shown high mercury levels in the water and fish tissue. A more complete study of the sources, sediment content and extent of the contamination is needed. Salmonoid propagation and benthic invertebrate studies should be undertaken.

10. Upper Blackfoot River Water Quality Study.

    Study is needed to determine the nature and extent of the damage caused by recent tailings pond break in the Heddleston mining district.

NOTE: In the appropriate studies, the economic and technical feasibility of solutions to water quality problems should also be investigated more to determine the cost effectiveness of the possible solutions.

PUBLIC HEARING

On Wednesday, October 22, 1975, the Water Quality Bureau conducted a public hearing to receive input into the Upper Clark Fork River Water Quality Inventory and Management Plan. Hearing officer for the hearing was M.K. Botz of the Water Quality Bureau. Mr. Casne of the Water Quality Bureau described the reason for the hearing and briefly described the contents of the water quality inventory and management plan. The only formal comment presented at the hearing was by the Anaconda Company. Important points of their formal presentation were: 1) The Anaconda Company did not believe that the report reflected recent information collected on Silver Bow Creek since the report was prepared, and they stated they would provide flow measurements and analytical results at critical points on the upper portions of the Clark Fork River which better reflect present conditions. 2) A clarification of the statement on Page 75 of the report respect to Butte's discharging system was made. It was stated that the Anaconda Company will develop a zero discharge of the concentrator system but not the mine water system. It was stated that water pumped from underground mines is put into the water system in the Butte operations and must be released after treatment, eliminating the possibility of a zero discharge system for the Butte complex. 3) Stream work done by the Anaconda Company on Silver Bow Creek between Butte and Warm Springs indicated a substantial increase in aquatic organisms in a significant portion of this stream. 4) Data in the report relative to metals and sulfate loading in Silver Bow Creek in 1974 should be revised according to new data obtained in 1974 and 1975, reflecting both reduced loads and a much larger data base. 5) The Anaconda Company recommended that the studies recommended in the report in Table 30 be done on the Upper Silver Bow Clark Upper Clark Fork River basin. In addition, they recommended that specific reference be made in these studies to: (a) determination of technically and economically feasible solutions to the problem, and (b) determination of the effectiveness of such solutions.

There were no additional comments relative to the water quality inventory and management plan, and the hearing was concluded. An additional 30-day period was allowed at the conclusion of this hearing for persons to submit comments or information to the Water Quality Bureau with respect to this plan.

APPENDIX A

GLOSSARY

Symbol	Definition
BOD_5	Five-day biochemical demand
cfs	Cubic feet per second
gpcd	Gallons per capita per day
gpd	Gallons per day
gpm	Gallons per minute
JTU	Jackson turbidity unit
lbs/capita/day	Pounds per capita per day
lbs/day	Pounds per day
ml	Milliliter
mgd	Million gallons per day
mg/l	Milligrams per liter
sq. ft.	Square feet
TR	Total recoverable
tpd	Tons per day
μmhos	Micromhos per centimeter
$<$	Less than
$\leq$	Less than or equal to
$\geq$	Greater than or equal to
$\sim$	Approximately
BPT	Best practical treatment
WQB	Montana Department of Health & Environmental Sciences, Environmental Sciences Division, Water Quality Bureau
F & G	Fish and Game, Montana Department of
MPHES	Montana Department of Health & Environmental Sciences
MPDES	Montana Pollutant Discharge Elimination System
NPDES	National Pollutant Discharge Elimination System
BuRec	Bureau of Reclamation
EPA	U. S. Environmental Protection Agency
NOAA	National Oceanographic and Atmospheric Administration
SCS	U. S. Department of Agriculture, Soil Conservation Service
USGS	U. S. Geological Survey
USPHS	U. S. Public Health Service

APPENDIX B

MONTANA STATE DEPARTMENT OF HEALTH
AND
ENVIRONMENTAL SCIENCES

MAC 16-2.14(10)-S14480 WATER QUALITY STANDARDS

(1) Policy statement. The following standards are adopted to establish maximum allowable changes in water quality and establish limits for pollutants which affect prescribed beneficial uses of state waters. The department adopts as a rule the policy that best practicable treatment and control of waste, activity and flow is to be provided to maintain dissolved oxygen and overall water quality at the highest possible levels, and water temperatures, coliform bacteria concentrations, dissolved chemical substances, toxic materials, radioactivity, turbidities, color, odor and other deleterious substances at the lowest possible levels.

(2) Application of standards. The water quality standards are composed of water-use classifications [section (4)], water-use descriptions and specific water quality criteria [section (5)], and general water quality criteria [section (6)].

(a) General water quality criteria apply to all state waters except where in this rule specific water quality criteria are more applicable to a specific water-use classification.

(b) In order to carry out the objective of the rule, existing discharges to state waters shall be brought into compliance with the standards as soon as practicable, and in no case later than three years from the effective date of the rule.

(3) Definitions. Unless statutory definition or the context otherwise requires in this rule:

"Conduit" means any artificial or natural duct, either open or closed, for conveying liquids or other fluids.

"Dewatered stream" means a perennial or intermittent stream whose water has been removed for one or more beneficial uses.

"EPA" means the U. S. Environmental Protection Agency.

"Intermittent stream" means a stream or portion of a stream that flows only in direct response to precipitation; it receives little or no water from springs and no long-continued supply from melting snow or other sources.

"Naturally occurring" means conditions or material present from runoff or percolation over which man has no control or from

developed land where all reasonable land, soil and water conservation practices have been applied. Conditions resulting from dams in existence as of July 1, 1971 are natural.

"Mixing zone" means that volume of state water wherein any pollutant may exceed allowable water quality standards.

"Pesticide" means insecticides, herbicides, rodenticides, fungicides or any substance or mixture of substances intended for preventing, destroying, controlling, repelling, altering life processes, or mitigating any insects, rodents, nematodes, fungi, weeds and other forms of plant or animal life.

"Residue" means oils, floating solids and sludge deposits.

"Sediment" means solid material settled from suspension in a liquid; mineral or organic solid material that is being transported or has been moved from its site of origin by air, water or ice and has come to rest on the earth's surface, either above or below sea level; or inorganic or organic particles originating from weathering, chemical precipitation or biological activity.

"Settleable solids" means inorganic or organic particles that are being transported or have been transported by water from the site or sites of origin and are settled or are capable of being settled from suspension.

"Sewer" means a pipe or conduit that carries wastewater or drainage water.

"State waters" means any body of water, irrigation system or drainage system, either surface or underground. This section shall not apply to irrigation waters where the waters are used up within the irrigation system and said waters are not returned to any other state waters. The term "state waters" as used in this rule does not include underground water.

"Storm sewer" or "storm drain" means a sewer that carries storm water and surface water, street wash and other wash waters, or drainage but excludes sewage and industrial wastes.

"True color" means the color of water from which the turbidity has been removed.

"Turbidity" means a condition in water or wastewater caused by the presence of suspended matter resulting in the scattering and absorption of light rays.

(4) Water-use classifications.

COLUMBIA BASIN

Clark Fork River Drainage

Clark Fork River:

Warm Springs drainage to Myers Dam . . . . . A-Open-D_1

Remainder of Warm Springs drainage . . . . . B-D_1

Silver Bow Creek drainage to Anaconda Company leach dump . . . . . B-D_1

Silver Bow Creek (main stem) from the confluence of Blacktail Deer Creek to Warm Springs Creek . . . . E-F

Yankee Doodle Creek drainage to and including the Butte water supply reservoir . . . . . A-Closed

Remainder of Yankee Doodle Creek drainage to Anaconda Company tailings pond . . . . . B-D_1

Blacktail Deer Creek drainage except portion of Basin Creek listed below . . . . . B-D_1

- Basin Creek drainage to and including the Butte water supply reservoir . . . . . A-Closed
- Remainder of Basin Creek drainage . . . . . B-D_1

All other tributaries to Silver Bow Creek from the confluence of Blacktail Deer Creek to Warm Springs Creek . . . . . B-D_1

Clark Fork River (main stem) from Warm Springs Creek to Cottonwood Creek . . . . . C-D_2

Clark Fork River (main stem) from Cottonwood Creek to the Little Blackfoot River . . . . . C-D_1

Tin Cup Joe Creek drainage to the Deer Lodge water supply intake . . . . . A-Closed

Remainder of Tin Cup Joe drainage . . . . . B-D_1

Clark Fork River drainage from the Little Blackfoot River to the Idaho state line except those portions of tributaries listed below . . . . . B-D_1

- Georgetown Lake and tributaries above Georgetown Dam . . . . . A-Open-D_1

Flint Creek drainage from Georgetown Dam to Farm-to-Market Highway No. 348 bridge about one mile west of Philipsburg except those portions of tributaries list below . . . . . B-D_1

Fred Burr Lake and headwaters from source to the outlet of the lake . . . . . A-Closed

Flint Creek (main stem) from Farm-to-Market Highway No. 348 bridge about one mile west of Philipsburg to the Clark Fork River . . . . . B-D_1

South Boulder Creek drainage to the Philipsburg water supply intake . . . . . A-Open-D_1

Remainder of South Boulder drainage . . . . . B-D_1

All other tributaries to Flint Creek from Farm-to-Market Highway No. 348 bridge to the Clark Fork River . . . . . B-D_1

All tributaries of Clark Fork River not otherwise mentioned . . . . . B-D_1

(5) Water-use description and specific water quality criteria.

(a) General. Specific water quality criteria, along with criteria in section (6) protect the beneficial water uses set forth in the water-use descriptions for the following classifications of water. Criteria for organisms of the coliform group are based on a minimum of five samples obtained during separate 24-hour periods during any consecutive 30-day period analyzed by the most probable number or equivalent membrane filter methods. The metal limits on the Clark Fork River [section (6)] are to govern when this section (5) imposes a conflicting requirement with criteria.

(b) A-Closed classification.

(i) Water-use description. Water supply for drinking, culinary and food processing purposes suitable for use after simple disinfection. Public access and activities such as livestock grazing and timber harvest are to be controlled by the utility owner under conditions prescribed and orders issued by the department. Only those waters on which access is presently controlled by the utility owner have been classified as A-Closed. If other uses are permitted, the waters are to be reclassified A-Open-D_1.

(ii) Specific water quality criteria.

(aa) The average number of organisms in the coliform group is not to exceed 50 per 100 milliliters.

(ab) Dissolved oxygen criteria are not applicable for the classification.

(ac) No change from natural pH is allowed.

(ad) No increase above naturally occurring turbidity is allowed.

(ae) No increase above naturally occurring water temperature is allowed.

(af) No increases above naturally occurring concentrations of sediment, settleable solids or residues, which adversely affect the use indicated, are allowed.

(ag) No increases of toxic or other deleterious substances, pesticides and organic and inorganic materials including heavy metals, above naturally occurring concentrations, are allowed.

(ah) No wastes are allowed which increase radioactivity above natural background levels.

(c) A-Open-D_1 Classification.

(i) Water-use description. Water supply for drinking, culinary and food processing purposes suitable for use after simple disinfection and removal of naturally present impurities. Water quality is to be maintained suitable for bathing, swimming and recreation; growth and propagation of salmonoid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply. Where the waters are used for swimming or other water-contact sports, analyses are to be made by the utility owner and the department to determine if a higher degree of treatment is required for potable water use.

Waters, if shown to meet the A-Closed criteria, may be so classified by the department at the request of the utility owner. State waters within the boundaries of national parks and nationally designated wild, wilderness or primitive areas in the state are classified A-Open-D_1 except those adjacent to developed areas such as Snyder Creek through the community of Lake McDonald and Swiftcurrent Creek below the Many Glacier Chalet, both in Glacier National Park. Also, Georgetown, Flathead and Whitefish Lakes and Lake Mary Ronan are classified A-Open-D_1 as are some streams presently used for domestic water supply.

(ii) Specific water quality criteria.

(aa) The average number of organisms in the coliform group is not to exceed 50 per 100 milliliters where demonstrated to be the result of domestic sewage.

(ab) Dissolved oxygen concentration is not to be reduced below 7.0 milligrams per liter.

(ac) Induced variation of hydrogen ion concentration (pH) within the range of 6.5 to 8.5 is to be less than 0.5 pH unit. Natural pH outside this range is to be maintained without change. Natural pH above 7.0 is to be maintained above 7.0.

(ad) No increase above naturally occurring turbidity is allowed.

(ae) A 1° F maximum increase above naturally occurring water temperature is allowed within the range of 32° F to 66° F; within the naturally occurring range of 66° F to 66.5° F, no discharge is allowed which will cause the water temperature to exceed 67° F; and where the naturally occurring water temperature is 66.5° F or greater, the maximum allowable increase in water temperature is 0.5° F. A 2° F per hour maximum decrease below naturally occurring water temperature is allowed when the water temperature is above 55° F, and a 2° F maximum decrease below naturally occurring water temperature is allowed within the range of 55° F to 32° F.

(af) No increases above naturally occurring concentrations of sediment, settleable solids or residues, which adversely affect the use indicated, are allowed.

(ag) Concentrations of toxic or other deleterious substances, pesticides and organic and inorganic materials including heavy metals, after treatment for domestic use, are not to exceed the recommended limits established in the 1962 U. S. Public Health Service Drinking Water Standards or subsequent editions; an increase of more than 10 percent of the concentration present in the receiving water is not allowed; maximum allowable concentrations are to be less than acute or chronic problem levels as revealed by bioassay or other methods.

(ah) True color is not to be increased more than two units above naturally occurring color.

(d) B-D_1 classification.

(i) Water-use description. The quality is to be maintained suitable for drinking, culinary and food processing purposes after adequate treatment equal to coagulation, sedimentation, filtration, disinfection and any additional treatment necessary to remove naturally present impurities; bathing, swimming and recreation; growth and propagation of salmonoid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.

(ii) Specific water quality criteria.

(aa) The average number of organisms in the fecal coliform group is not to exceed 200 per 100 milliliters, nor are 10 percent of the total samples during any 30-day period to exceed 400 fecal coliforms per 100 milliliters. The average number of organisms in the coliform group is not to exceed 1,000 per 100 milliliters, nor are 20 percent of the samples to exceed 1,000 coliforms per 100 milliliters during any 30-day period.

(ab) Dissolved oxygen concentration is not to be reduced below 7.0 milligrams per liter.

(ac) Induced variation of hydrogen ion concentration (pH) within the range of 6.5 to 8.5 is to be less than 0.5 pH unit. Natural pH outside this range is to be maintained without change. Natural pH above 7.0 is to be maintained above 7.0.

(ad) The maximum allowable increase above naturally occurring turbidity is 5 Jackson Candle Units except as is permitted in the general water quality criteria.

(ae) A 1° F maximum increase above naturally occurring water temperature is allowed within the range of 32° F to 66° F; within the naturally occurring range of 66° F to 66.5° F, no discharge is allowed which will cause the water temperature to exceed 67° F; and where the naturally occurring water temperature is 66.5° F or greater, the maximum allowable increase in water temperature is 0.5° F. A 2° F per hour maximum decrease below naturally occurring water temperature is allowed when the water temperature is above 55° F, and 2° F maximum decrease below naturally occurring water

temperature is allowed within the range of 55° F to 32° F.

This applies to all waters in the state classified B-D_1 except for Prickly Pear Creek from McClellan Creek to the Montana Highway No. 433 crossing where a 2° F maximum increase above naturally occurring water temperature is allowed within the range of 32° F to 65° F; within the naturally occurring range of 65° F to 66.5° F, no discharge is allowed which will cause the water temperature to exceed 67° F; and where the naturally occurring water temperature is 66.5° F or greater, the maximum allowable increase in water temperature is 0.5° F.

(af) No increases above naturally occurring concentrations of sediment, settleable solids or residues, which adversely affect the use indicated, are allowed.

(ag) Concentrations of toxic or other deleterious substances, pesticides and organic and inorganic materials including heavy metals, after treatment for domestic use, are not to exceed the recommended limits contained in the 1962 U.S. Public Health Service Drinking Water Standards or subsequent editions; also, maximum allowable concentrations are to be less than acute or chronic problem levels as revealed by bioassay or other methods.

(ah) True color is not to be increased more than five units above naturally occurring color.

(g) <u>C-D_1 classification</u>.

(i) Water-use description. The quality is to be maintained suitable for bathing, swimming and recreation; growth and propagation of salmonoid fishes and associated aquatic life, waterfowl and furbearers, and agricultural and industrial water supply.

(ii) Specific water quality criteria.

(aa) The average number of organisms in the fecal coliform group is not to exceed 200 per 100 milliliters nor are 10 percent of the total samples during any 30-day period to exceed 400 fecal coliforms per 100 milliliters. The average number of organisms in the coliform group is not to exceed 1,000 per 100 milliliters nor are 20 percent of the samples to exceed 1,000 coliforms per 100 milliliters during any 30-day period.

(ab) Dissolved oxygen concentration is not to be reduced below 7.0 milligrams per liter.

(ac) Induced variation of hydrogen ion concentration (pH) within the range of 6.5 to 8.5 is to be less than 0.5 pH unit. Natural pH outside this range is to be maintained without change. Natural pH above 7.0 is to be determined above 7.0.

(ad) The maximum allowable increase above naturally occurring turbidity is 5 Jackson Candle Units, except as is permitted in the general water quality criteria.

(ae) A 1° F maximum increase above naturally occurring water temperature is allowed within the range of 32° F to 66° F; within the naturally occurring range of 66° F to 66.5° F, no discharge is allowed which will cause the water temperature to exceed 67° F; and where the naturally occurring water temperature is 66.5° F or greater, the maximum allowable increase in water temperature is 0.5° F. A 2° F per hour maximum decrease below naturally occurring water temperature is allowed when the water temperature is above 55° F, and a 2° F maximum decrease below naturally occurring water temperature is allowed within the range of 55° F to 32° F.

(af) No increases above naturally occurring concentrations of sediment, settleable solids or residues, which adversely affect the use indicated, are allowed.

(ag) Concentrations of toxic or other deleterious substances, pesticides and organic and inorganic materials including heavy metals, are not to exceed levels known or demonstrated to be of public health significance; also maximum allowable concentrations are to be less than acute or chronic problem levels as revealed by bioassay or other methods.

(ah) True color is not to be increased more than five units above naturally occurring color.

(h) <u>C-D_2 classification</u>.

(i) Water-use description. The quality is to be maintained for bathing, swimming and recreation; growth and marginal propagation of salmonoid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.

(ii) Specific water quality criteria.

(aa) The average number of organisms in the fecal coliform group is not to exceed 200 per 100 milliliters nor are 10 percent of the total samples during any 30-day period to exceed 400 fecal coliforms per 100 milliliters. The average number of organisms in the coliform group is not to exceed 1,000 per 100 milliliters nor are 20 percent of the samples to exceed 1,000 coliforms per 100 milliliters during any 30-day period.

(ab) Dissolved oxygen concentration is not to be reduced below 7.0 milligrams per liter from October 1 through June 1 nor below 6.0 milligrams per liter from June 2 through September 30.

(ac) Induced variation of hydrogen ion concentration (pH) within the range of 6.5 to 9.0 is to be less than 0.5 pH unit. Natural pH outside this range is to be maintained without change. Natural pH above 7.0 is to be maintained above 7.0.

(ad) The maximum allowable increase above naturally occurring turbidity is 10 Jackson Candle Units, except as is permitted in the general water quality criteria.

(ae) A 1° F maximum increase above naturally occurring water temperature is allowed within the range of 32° F to 66° F; within the naturally occurring range of 66° F to 66.5° F, no discharge is allowed which will cause the water temperature to exceed 67° F; and where the naturally occurring water temperature is 66.5° F or greater, the maximum allowable increase in water temperature is 0.5° F. A 2° F per hour maximum decrease below naturally occurring water temperature is allowed when the water temperature is above 55° F, and a 2° F maximum decrease below naturally occurring water temperature is allowed within the range of 55° F to 32° F.

(af) No increases above naturally occurring concentrations of sediment, settleable solids or residues, which adversely affect the use indicated, are allowed.

(ag) Concentrations of toxic or other deleterious substances, pesticides and organic and inorganic materials including heavy metals, are not to

exceed levels known or demonstrated to be of public health significance; also maximum allowable concentrations are to be less than acute or chronic problem levels as revealed by bioassay or other methods.

(ah) True color is not to be increased more than five units above naturally occurring color.

(d) E-F classification.

(i) Water-use description. The quality is to be maintained for agricultural and industrial water uses other than food processing.

(ii) Specific water quality criteria.

(aa) The average number of organisms in the fecal coliform group is not to exceed 200 per 100 milliliters nor are 10 percent of the total samples during any 30-day period to exceed 400 fecal coliforms per 100 milliliters. The average number of organisms in the coliform group is not to exceed 1,000 per 100 milliliters nor are 20 percent of the samples to exceed 1,000 coliforms per 100 milliliters during any 30-day period.

(ab) Dissolved oxygen concentration is not to be reduced below 3 milligrams per liter.

(ac) Induced variation of hydrogen ion concentration (pH) within the range of 6.5 to 9.5 is to be less than 0.5 pH unit. Natural pH outside this range is to be maintained without change. Natural pH above 7.0 is to be maintained above 7.0.

(ad) Naturally occurring turbidity, naturally occurring water temperatures and naturally occurring concentrations of sediments, settleable solids or residues are not to be increased in quantity or amounts which adversely affect the use indicated.

(ae) Concentrations of toxic or deleterious substances, pesticides and organic and inorganic materials including heavy metals, are to be less than those demonstrated to be deleterious to livestock or plants or their subsequent consumption by humans or to adversely affect other indicated uses.

(6) General water quality criteria.

(a) The degree of waste treatment required to restore and maintain the standards is to be determined by the department and is to be based on the following.

(i) The state's policy of nondegradation of existing high water quality as described in Section 69-4808.2, R.C.M. 1947.

(ii) Present and anticipated beneficial uses of the receiving water.

(iii) The quality and nature of flow of the receiving water.

(iv) The quantity and quality of the sewage, industrial waste or other waste to be treated.

(v) The presence or absence of other sources of pollution on the same watershed.

(b) Sewage is to receive a minimum of secondary treatment as defined by EPA in accordance with requirements as set forth in the Federal Water Pollution Control Act Amendments of 1972.

(c) Industrial waste is to receive, as a minimum, treatment equivalent to the best practicable control technology currently available (BPCT) as defined by EPA. In cases where BPCT is not defined by EPA, industrial waste is to receive, after maximum practicable in-plant control, a minimum of secondary treatment or equivalent.

(d) For design of disposal systems, stream flow dilution requirements are to be based on minimum consecutive seven-day average flow which may be expected to occur on the average of once in ten years. When dilution flows are less than the above design flow at a point discharge, the discharge is to be governed by the permit conditions developed for the discharge through the waste discharge permit program.

(e) State surface waters are to be free from substances attributable to municipal, industrial, agricultural practices or other discharges that will:

(i) Settle to form objectionable sludge deposits or emulsions beneath the surface of the water or upon adjoining shorelines.

(ii) Create floating debris, scum, a visible oil film (or be present in concentrations at or in excess of 10 milligrams per liter) or globules of grease or other floating materials.

(iii) Produce odors, colors or other conditions as to create a nuisance or render undesirable tastes to fish flesh or make fish inedible.

(iv) Create concentrations or combinations of materials which are toxic or harmful to human, animal, plant or aquatic life.

(v) Create conditions which product undesirable aquatic life.

(f) No wastes are to be discharged and no activities conducted such that the wastes or activities, either alone or in combination with other wastes or activities, will violate, or can reasonably be expected to violate, any of the standards; (e.g., in a reach of stream classified B-D_1 the total allowable cumulative increase to naturally occurring turbidity conditions in the reach is 5 Jackson Candle Units).

(g) No wastes are to be discharged and no activities conducted which, either alone or in combination with other wastes or activities, will cause turbidities to exceed those allowed by specific water quality criteria; provided, short-term activities necessary to accommodate essential dredging, channel or bank alterations, stream diversions or other construction where turbidities in excess of the criteria are unavoidable, may be authorized by the department under conditions as it may prescribe.

(h) Methods of sample collection, preservation and analysis used to determine compliance with the standards are to be in accordance with the latest edition of Standard Methods for the Examination of Water and Wastewater published by the American Public Health Association or in accordance with tests or procedures that have been found to be equally or more applicable.

(i) For operations of existing water impoundments that cause conditions harmful to prescribed beneficial uses of state waters, it is to be demonstrated to the satisfaction of the department that continued operations will be done in the best practicable manner to minimize harmful effects and will not violate state laws or department rules. New water impoundments shall be designed to provide temperature variations in discharging water that maintain or enhance the existing propagating fishery and associated aquatic life. As a guide, the following temperature variations are recommended: Continuously less than 40° F during the months of January and February, and continuously greater than 44° F during the months of June through September.

(j) Ponds for waste treatment purposes are not to be located in drainage ways where the volume of drainage water from a 10-year storm entering the ponds exceeds one-half the volume of the pond; provided that, subject to approval by the department as to design and maintenance, ponds located in drainage ways for the express purpose of containing emergency oil spills are permitted.

(k) Dumping of snow from municipal and/or parking lot snow removal activities into waters of the state is prohibited without a permit from the department.

(l) Existing discharges to state waters will be entitled a mixing zone as determined by the department.

(m) Until such time as minimum stream flows are established for dewatered streams, the minimum treatment requirements for discharges to dewatered receiving streams are to be no less than the minimum treatment requirements prescribed.

(n) Treatment requirements for discharges to intermittent streams are to be no less than the minimum treatment requirements prescribed.

(o) Pollution resulting from storm drainage, storm sewer discharges, and non-point sources, including irrigation practices, road building, construction, logging practices, overgrazing and other practices, are to be eliminated or minimized as ordered by the department.

(p) Application of pesticides in or adjacent to state waters is to be in compliance with the labeled direction, and in accordance with provisions of the Montana Pesticides Act (Title 27, Chapter 2, R.C.M. 1947) and the Federal Environmental Pesticides Control Act (Public Law 92-516). Excess pesticides and pesticide containers are not to be disposed of in a manner or in a location where they are likely to pollute state waters.

(q) The following radiological criteria shall apply to all waters except those classified as A-Closed:

(i) The average dissolved concentrations (including the naturally occurring or background contribution) of iodine 131, radium-226, strontium-89, strontium-90 and tritium are not to exceed the following concentration limits:

Iodine-131	5 pCi/L
Radium-226	1 pCi/L
Strontium-89	100 pCi/L
Strontium-90	10 pCi/L
Tritium	3,000 pCi/L

For all other radionuclides, the average dissolved concentration limits are to be 1/150 of the corresponding maximum permissible concentration in water for continuous occupational exposure as recommended by the National Committee on Radiation Protection (National Bureau of Standards Handbook 69 or subsequent revisions.)

(ii) For a mixture of radionuclides, the following relationship is to be satisified:

$$\frac{C_1}{L_1} + \frac{C_2}{L_2} \cdot \cdot \cdot + \frac{C_n}{L_n} \leq 1.00$$

C denotes the average concentration of the respective radionuclide, and L denotes its concentration limit.

(iii) Where alpha emitters, strontium-90, radium-228, iodine-129, iodine-130, and lead-210 are known to be absent, routine analyses for dissolved gross beta radioactivity (excluding potassium-40 contribution) may be employed to monitor and show compliance with this criterion (except for tritium) as long as the gross concentration does not exceed 100 pCi/L. When these conditions are not met, routine quantitative analyses of individual radionuclides are to be performed to show compliance. Except in cases where tritium from other than natural sources is known to be absent, routine tritium analyses are to be performed to show compliance. (Note: "Absence" means a negligibly small fraction of the specific concentration limit, where the limit for unidentified alpha emitters is taken as the limit for radium-226.)

(iv) For radionuclides associated with suspended material in transport, the average concentration limits are to be 1/150 of the corresponding maximum permissible concentration in water (insoluble form) for continuous occupational exposure as recommended by the National Committee on Radiation Protection. In-stream sedimentation of these materials is not to produce solids beds that are not in compliance with subsections (q) (i) and (q) (ii) (because of leaching) and/or excessive accumulation in native flora and fauna.

(v) Average concentrations are to be computed from monitoring data acquired during the previous 12 months; maximum concentrations are not to exceed three times the average concentration limits specified.

(vi) Variances from concentration limits specified will be permitted only if the contributing source is non-controllable or a natural source. Best available treatment must be provided for man-made discharges, and the exposure received by affected population groups must be within established dose limits.

(r) No wastes are to be discharged and no activities conducted which, either alone or in combination with other wastes or activities, will result in the dissolved gas content relative to the water surface to exceed 110 percent of saturation.

(s) Bioassay median tolerance concentrations are to be based on latest available research results for the materials, by bioassay tests procedures for simulating actual stream conditions as set forth in the latest edition of Standard Methods for the Examination of Water and Wastewater published by the American Public Health Association, or in accordance with tests or analytical procedures that have been found to be equal or more applicable by EPA. Bioassay studies are to be made using the most sensitive local species and life stages of economic or ecological importance; provided other species whose relative sensitivity is known may be used when there is difficulty in providing the most sensitive species in sufficient numbers.

When specific application factors are not available, the factor is to be determined by using methods listed in Water Quality Criteria published by the Federal Water Pollution Control Administration (1968), or by using other methods accepted as equal or applicable by EPA.

(t) Metal limits for the Clark Fork River (main stem) from the confluence of Warm Springs Creek to the confluence with Cotton Creek are:

Material	Average Daily concentration ug/l	Maximum Instantaneous Concentration ug/l
Total copper	90	180
Dissolved copper	30	40
Total zinc	300	1,000
Dissolved zinc	80	140
Total iron	1,300	2,200
Dissolved iron	150	160
Total lead	100	100
Dissolved lead	100	100
Total cadmium	10	10
Total arsenic	10	16
Total mercury	1	1

Metal limits for Clark Fork River (main stem) from the confluence of Cottonwood Creek to the Idaho state line are:

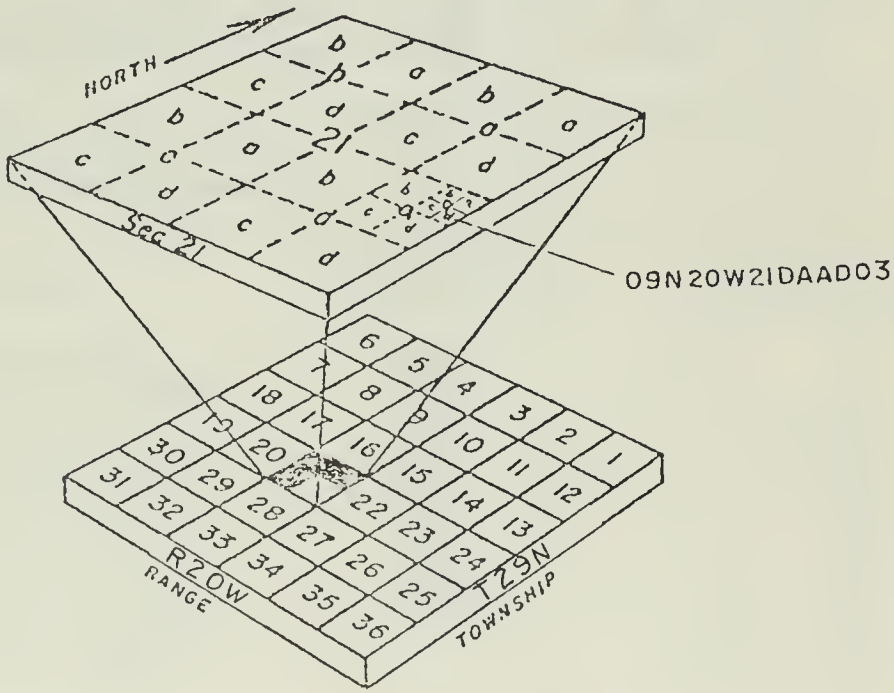
Material	Average Daily Concentration ug/l	Maximum Instantaneous Concentration ug/l
Total copper	50	90
Dissolved copper	30	30
Total zinc	100	200
Dissolved zinc	70	80
Total iron	300	1,300
Dissolved iron	150	150
Total lead	50	50
Dissolved lead	50	50
Total cadmium	10	10
Total arsenic	10	10
Total mercury	1	1

(History: Sec. 69-4814, R.C.M. 1947; IMP Sec. 69-4808.2 (1) (b), R.C.M. 1947; Order MAC No. 16-1; Adp. 12/31/72; Eff. 12/31/72; AMD, MAC Notice No. 16-2-3, Order MAC No. 16-2-5; Adp. 7/13/73; Eff. 11/4/73; PRIOR p. 16-375; AMD, MAC Notice No. 16-2-31; Order MAC No. 16-2-11; Adp. 7/19/74; Eff. 9/5/74; PRIOR p. 16-387, 391, 393, 393.1, 393.4.).

APPENDIX C

SYSTEM FOR GEOGRAPHICAL LOCATION OF FEATURES

Features such as water sampling sites, wells, and springs are assigned a location number that is based on the system of land subdivision used by the U. S. Bureau of Land Management. The number consists of fifteen characters and describes the location by township, range, section and position within the section. The figure below illustrates this numbering method. The first three characters of the number give the township, the next three the range. The next two numbers give the section number within the township, and the next four letters describe the location within the quarter section (160-acre tract), and quarter-quarter section (40-acre tract), and a quarter-quarter-quarter section (10-acre tract), and the quarter-quarter-quarter-quarter (2 1/2-acre tract). These subdivisions of the 640-acre section are designated as A, B, C, and D in a counterclockwise direction, beginning in the northeast quadrant. If there is more than one feature in a 2 1/2-acre tract, consecutive digits beginning with the number 02 are added to the number. For example, if a water quality sample was collected in Section 21, T29N, R20W it would be numbered 29N20W21DAAD02. The letters DAAD indicate that the well is in the southeast 1/4 of the northeast 1/4 of the northeast 1/4 of the southeast 1/4, and the number 02 following the letters DAAD indicates that there is more than one site location in this 2 1/2-acre tract.



APPENDIX D

TABLE 31. STATEWIDE PRIORITY LIST FOR CONSTRUCTION GRANTS PROGRAM
EFFECTIVE MARCH 11, 1975

COMMUNITY	STREAM SEGMENT	WATER USE	POPULATION SERVED	SCOPE OF PROJECT	PHASE CONSTRUCTION	TOTAL POINTS
Three Forks	6	6	2	30	30	74
Great Falls	4	4	3	30	30	71
*Butte	8	2	3	40		53
Corvallis	6	6	1	40		53
Victor	6	6	1	40		53
Miles City	6	2	2	40		50
Poplar	6	2	2	40		50
Blgs. 6th Ave. N. Int.	4	2	3	40		49
Whitefish	8	6	2	30		46
Columbia Falls	8	6	2	30		46
Polson	8	6	2	30		46
Gallatin County RID 305	8	6	2	30		46
Bozeman	8	4	3	30		45
*Anaconda-Opportunity	6	6	3	30		45
Bigfork	8	6	1	30		45
Livingston	6	6	2	30		44
Dillon	6	6	2	30		44
Libby	6	6	2	30		44
Hamilton	6	6	2	30		44
Red Lodge	6	6	2	30		44
Big Timber	6	6	2	30		44
Choteau	6	6	2	30		44
Townsend	6	6	2	30		44
Thompson Falls	6	6	2	30		44
Boulder	6	6	2	30		44
White Sulphur Springs	6	6	2	30		44
Eureka	6	6	2	30		44
Whitehall	6	6	2	30		44
Stevensville	6	6	1	30		43
Manhatten	6	6	1	30		43
Lodge Grass	6	6	1	30		43
Sheridan	6	6	1	30		43
Sunburst	6	6	1	30		43
Absarokee	6	6	1	30		43
Darby	6	6	1	30		43
Ennis	6	6	1	30		43
Drummond	6	6	1	30		43
East Glacier	6	6	1	30		43
Roberts	6	6	1	30		43
Hobson	6	6	1	30		43
Bearcreek	6	6	1	30		43
Lewistown	6	4	2	30		42
Laurel	6	4	2	30		42
Hardin	6	4	2	30		42
Harlowton	6	4	2	30		42

COMMUNITY	STREAM SEGMENT	WATER USE	POPULATION SERVED	SCOPE OF PROJECT	PHASE CONSTRUCTION	TOTAL POINTS
Great Falls Sewers	4	4	3	15		26
*Butte Sewers	8	2	1	15		26
Lewistown Sewers	6	4	1	15		26
Conrad	6	4	1	15		26
St. Ignatius Sewers	6	4	1	15		26
Helena Sewers	6	2	2	15		25
Helena Valley	6	2	2	15		25
Fort Benton	6	2	2	15		25
Ashland	6	2	2	15		25
*Lincoln	2	6	2	15		25
Billings Sewers	4	2	3	15		24
Miles City Sewers	6	2	1	15		24
Sidney Sewers	6	2	1	15		24
Roundup Sewers	6	2	1	15		24
Stockett	2	6	1	15		24
Simms	2	6	1	15		24
Kremlin	6	2	1	15		24
Geyser	6	2	1	15		24
Havre Sewers	4	2	2	15		23
Kalispell Storm Sewers	8	2	3	10		23
Billings Heights	4	2	2	15		23
Huntley	4	2	1	15		22
Gt. Fls. Storm Sewer Sep.	4	4	3	10		21
Chinook	6	2	2	10		20
Power Teton-Co. W. Assoc.	2	2	1	15		20
Cut Bank Water Treatment	6	6	2	5		19

An acceptable application must be submitted within 90 days of notification by the Department.

*Communities in the Upper Clark Fork River Basin.

BIBLIOGRAPHY

Anaconda Company's, The, Proposal for Development of the Heddleston Mining District, Lewis & Clark County, Montana. Briefing, March 18, 1970.

Anaconda Company, The, and the Deerlodge National Forest, Warm Springs Creek Watershed. Cooperative Watershed Management Plan.

Belding, D. L., 1928. "Water Temperature and Fish Life." Trans. Am. Fish. Soc.:58.

Bigart, Robert, Edited by. 1972. Environmental Pollution in Montana. Mountain Press Publishing Company, Missoula, MT

Botz, M. K. Sept., 1969. Hydrogeology of the Upper Silver Bow Creek Drainage Area, Montana. Montana College of Mineral Science and Technology, Butte, MT. Duration June, 1966 - July, 1966.

Braico, Robert D. Sept, 1973. Dissolved Oxygen and Temperature Diurnal Variations in the Clark Fork River between Deer Lodge and Superior, Montana. Water Quality Bureau, Environmental Sciences Division, Montana Department of Health and Environmental Sciences. 33p.

Brown, C. J. D. 1971. Fishes of Montana. Big Sky Books. Montana State University, Bozeman, Montana. 207 p.

Coffin, D. L., and K. R. Wilke. 1971. Water Resources of the Upper Blackfoot River Valley, West-Central Montana. Montana Department of Natural Resources and Conservation, Water Resources Division.

Columbia River Drainage in Montana. March - November, 1957 Studies. An extensive Chemical, Physical, Bacteriological & Biological Survey. Water Pollution Control, Report No. 59-1, State Board of Health.

Department of Chemistry, Geochemistry Section, Montana College of Mineral Science & Technology, Butte, Montana in cooperation with Montana Department of Health & Environmental Sciences, Helena, Montana and The Anaconda Company, Butte, Montana. January, 1974. Influence of Industrial, Municipal, & Private Wastes on Water Quality of a Portion of the Upper Clark Fork River Drainage - A Reconnaissance Study.

Department of Chemistry, Geochemistry Section, Montana College of Mineral Science & Technology, Butte, Montana in cooperation with The Anaconda Company, Butte, Montana. September, 1974. Influence of Industrial, Municipal & Private Wastes on Water Quality of a Portion of the Upper Clark Fork River Drainage.

Directory of Mining Enterprises for 1973. April, 1974.

Earll, F. N. 1972. Mines and Mineral Deposits of the Southern Flint Creek Range, Montana. Montana College of Mineral Science and Technology, Butte, Montana.

Embody, G.C., 1921. "Concerning High Water Temperatures and Trout." Trans. Am. Fish. Soc.: 51.

Emigh, G. Donald. Economic Phosphate Deposits.

Emmons, William Harvey & Frank Cathcart Calkins. 1913. Geology and Ore Deposits of the Philipsburg Quadrangle, Montana. Washington Government Printing Office.

Environmental Protection Agency. 1972. A Water Quality Study of the Upper Clark Fork River and Selected Tributaries. Region VIII, Denver, Colorado 39 p.

Fox, Robert L. April 6-8, 1972. Silver Bow Creek - Clark Fork Survey. Technical Support Branch, Surveillance & Analysis Division Environmental Protection Agency, Region VIII, Denver, Colorado.

Georgetown Lake Pre-study. June 1, 1973. Prepared for the Deer Lodge-Granite County Commissioners and Conservation District Supervisors.

Gless, Elmer E. 1973. Influence of Industrial, Municipal, and Private Wastes on Water Quality of a Portion of the Upper Clark Fork River Drainage - A Reconnaissance Study. Ecological Studies of Silver Bow & Blacktail Creeks & Upper Clark Fork River: Silver Bow, Powell, & Deer Lodge Counties, Montana. Montana College of Mineral Sciences & Technology, Butte, Montana.

Griffith, Edward J., Et. Al. 1973. Environmental Phosphorus Handbook.

Haugen, Gordon N. March 1974. Rock Creek Fishery Habitat & Water Quality Study - Lolo & Deerlodge National Forests. Fishery Biologists, Project Coordinator, Rock Creek Fishery Habitat & Water Quality Study.

Haugen, Gordon N. March 1974. Rock Creek Fisheries Habitat & Water Quality Study - Intragravel Environment Progress Report No. 3, Lolo National Forest, Northern Region. Fisheries Biologist, Project Coordinator, Rock Creek, Fishery Habitat & Water Quality Study.

Headwaters RC&D Project Plan, Montana. U.S. Department of Agriculture, Soil Conservation Service, Bozeman, Montana.

Juday, Richard E. & Edward J. Keller. Preliminary Six Months Report on a Water Quality Survey of Placid Lake and Its Drainages.

Kendall, William Converse, 1924. "The Status of Fish Culture in our Inland Public Waters and the Role of Investigation in the Maintenance of Fish and Resources." Roosevelt Wildlife Bulletin: 2(3).

Lawson, Don C. 1974. Directory of Mining Enterprises for 1973. Montana College of Mineral Science and Technology, Butte, Montana.

Marcoux, R.G. 1974. Fish Management Surveys. Job Progress Report Federal Aid in Fish and Wildlife Restoration Acts. Montana Project No. F-12-R-19. Job No. 1-b.

MiGonigle, R.M. 1934. "Algae, A Factor in Some Hatchery Mortalities." Transactions American Fisheries Society: 64.

Montana Bureau of Mines & Geology, Hydrology Division, Montana College of Mineral Science & Technology, Butte, Montana in cooperation with Montana Department of Health & Environmental Sciences, Helena, Montana and the Anaconda Company, Butte, Montana. March 1974. Influence of Industrial, Municipal and Private Wastes on Water Quality of the Upper Clark Fork River Drainage - A Reconnaissance Study. Duration - June 1972 - December 1973.

Montana Department of Fish and Game, 1973. Flint Creek Files, Helena, Montana.

Montana Department of Fish and Game, 1971. Clark Fork Files, Helena, Montana.

Montana University Joint, Water Sources Research Center. Tenth Annual Report. Fiscal Year Ending June 30, 1974. Montana State University, Bozeman, Montana.

Needham, Paul R., 1938. Trout Streams. Comstock Publishing Co., Inc. Ithaca, New York.

_____ "A Quantitative Study of the Fish Food Supply in Selected Areas." Supp. 17th Ann. Rept., (1927). Dept., Cons., J.B. Lynn, Albany, New York (1928).

North End Planning Unit, April 1973. Deer Lodge National Forest, Multiple Use Plan, Part II.

Placid-Blanchard Planning Unit, Dec. 1973. Management Alternatives. Seeley Lake Ranger District, Lolo National Forest.

Sahinen, Uuno M., Jan. 1957. Mines and Mineral Deposits, Missoula and Ravalli Counties, Montana. Montana Bureau of Mines and Geology, Butte, Montana.

Spence, Liter E. 1974. Upper Blackfoot River Study. A Pre-mining Inventory of Aquatic and Wildlife Resources. Montana Department of Fish and Game.

Spindler, John C. 1949. An Extensive Chemical, Physical, Bacteriological and Biological Survey, Columbia River Drainage in Montana. Progress Report No. 59-1. Montana State Board of Health.

State of Montana - Volume 8. Comprehensive Area-Wide Water and Sewer Plan, 1970. Lewis & Clark, Broadwater & Meagher Counties.

State of Montana - Volume 12. Comprehensive Area-Wide Water and Sewer Plan, 1970. Deer Lodge & Silver Bow Counties.

Streebin, Leale E. Et. Al. 1973. Water Quality Study of the Clearwater River and Selected Tributaries. School of Civil Engineering and Environmental Sciences. University of Oklahoma, Norman, Oklahoma, 154 p.

Streebin, Leale E. Rock Creek II. A Continuation of the Rock Creek Water Quality Study.

University of Oklahoma, Norman, Oklahoma, School of Civil Engineering and Environmental Science. February, 1972. Rock Creek II. A Continuation of the Rock Creek Water Quality Study.

University of Oklahoma, Norman, Oklahoma, School of Civil Engineering and Environmental Science. March, 1972. Water Quality Survey. Lolo National Forest.

University of Oklahoma, Norman, Oklahoma, School of Civil Engineering and Environmental Science. April, 1973. Water Quality Study of the Clearwater River and Selected Tributaries.

Wayne P. Van Meter. Department of Chemistry, University of Montana, Missoula, Montana. August, 1974. Heavy Metal Concentration in Fish Tissue of the Upper Clark Fork River. Montana University Joint Water Resources Research Center, Bozeman, Montana.

Water Resources Survey. June, 1955. Deer Lodge County, Montana, Part I, History of Land and Water Use on Irrigated Areas. State Engineer's Office, Helena, Montana.

Water Resources Survey. June, 1959. Granite County, Montana, Part I, History of Land and Water Use on Irrigated Areas. State Engineer's Office, Helena, Montana.

Water Resources Survey. June, 1957. Lewis and Clark County, Montana, Part I, History of Land and Water Use on Irrigated Areas. State Engineer's Office, Helena, Montana.

Water Resources Survey. June, 1960. Missoula County, Montana, Part I, History of Land and Water Use on Irrigated Areas, State Engineer's Office, Helena, Montana.

Water Resources Survey. June, 1959. Powell County, Montana, Part I, History of Land and Water Use on Irrigated Areas. State Engineer's Office, Helena, Montana.

Water Supply and Pollution Control, Butte-Anaconda Area. The Anaconda Company.

Weed, Walter Harvey. 1912. Geology and Ore Deposits of the Butte District, Montana. Washington Government Printing Office.

Weisel, George F. Water Quality Studies on the Big Blackfoot and Clark Fork Rivers in Western Montana.

Western Montana Fishery Investigations; Inventory of Waters of the Project Area. Period covered-June 1, 1972 to June 30, 1973. Clark Fork River and Hoerner Waldorf pgs. 2-34. Flint Creek Fish Data, pgs. 43 and 44.

Wigal, Tom. Anaconda Constructs New Water Pollution Control System for the Clark Fork.

Wipperman, A.H. 1974. Clark Fork River Invertebrate Survey, 1973. Montana Department of Fish and Game, Helena, Montana.

Wright, John C. 1974. An Investigation into the Cause and Extent of Eutrophication in Georgetown Lake, Montana WRRC 10th Annual Report, Montana State University.

UPPER CLARK FORK RIVER BASIN

PLATE — I

WATER QUALITY BUREAU
STATE DEPARTMENT OF HEALTH
AND ENVIRONMENTAL SCIENCES

EXPLANATION

- PAVED ROADS
- UNIMPROVED ROADS
- RAILROADS
- STATE BOUNDARY
- COUNTY BOUNDARY
- PERENNIAL STREAM
- INTERMITTENT STREAM
- △ WATER QUALITY SAMPLING SITE
- ● STREAM FLOW GAGING STATION
- ■ SEWAGE TREATMENT PLANT
- □ SEWAGE TREATMENT LAGOON
- ◪ WATER TREATMENT PLANT
- ✱ INDUSTRIAL WATER DISCHARGE
- ▲

0 2 4 6 8 10

SCALE: 1/4" = 1 MILE

NOTE: THIS MAP WAS COMPILED FROM THE MONTANA STATE HIGHWAY DEPARTMENT COUNTY MAP SHEETS.